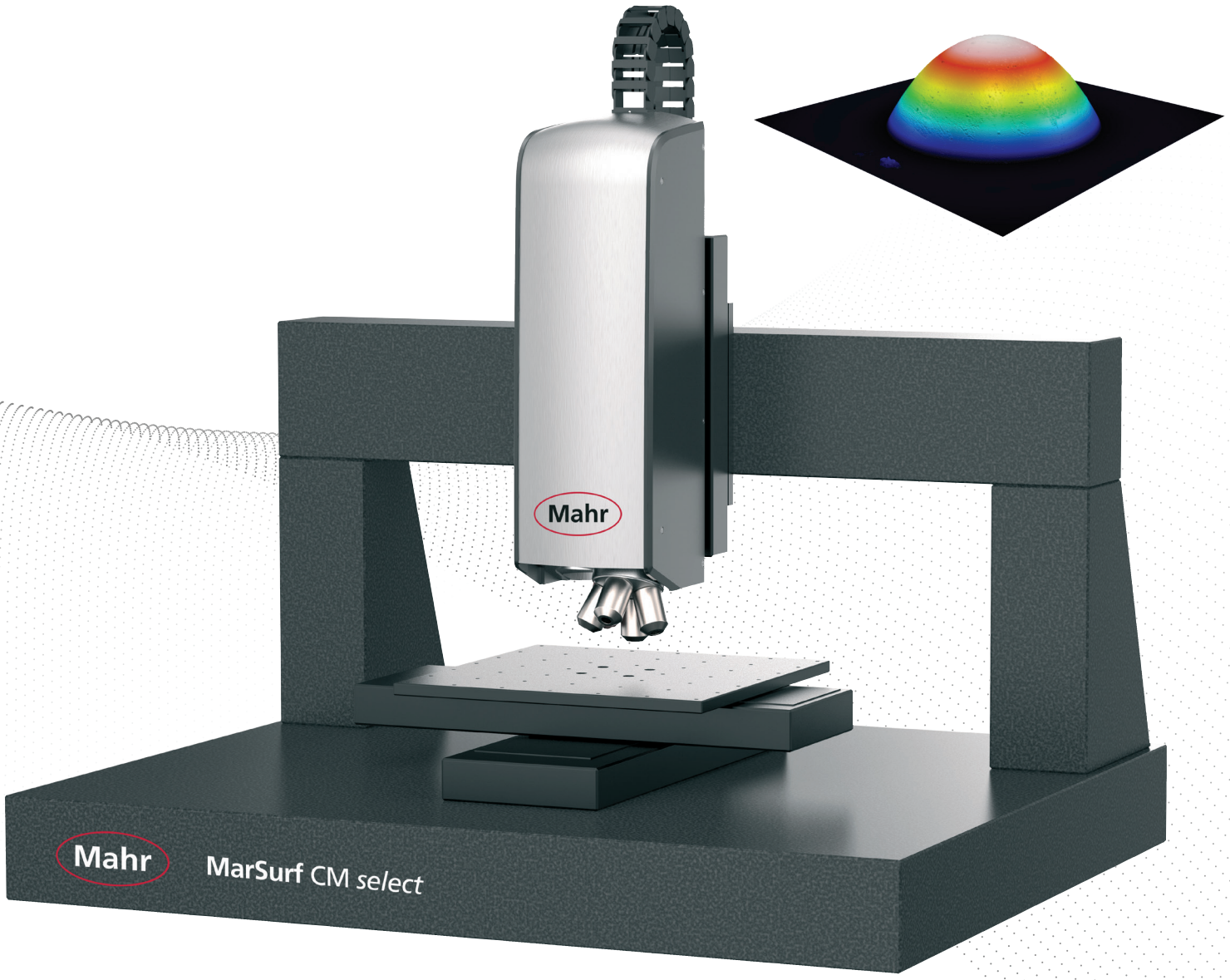
Automatic 3D geometry and roughness inspection for -

Challenging micro-lens measurement tasks

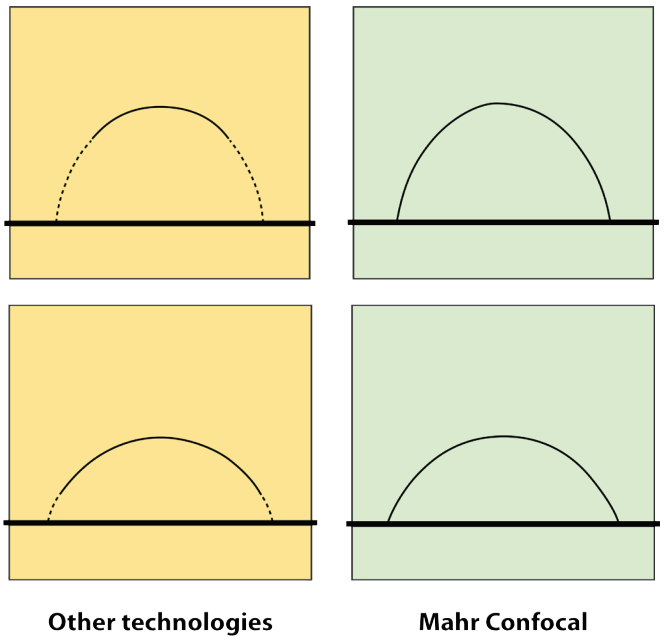


The current manufacturing trend to smaller diameters in micro-lenses presents several technical challenges for metrology instruments. Steep flanks at the edges of the lenses cause data drop-out for some optical technologies. The high performance requirements for these lenses dictate 100% inspection in many cases. So, extremely fast measurement times are needed. Due to the wide range of different materials used to manufacture these lenses, metrology instrument performance must be material insensitive. The MarSurf CM confocal technology easily meets all of these challenges.

The big challenge: steep flanks and decreasing diameters

One of the biggest challenges in acquiring high quality data from small diameter micro-lenses is the steep angle on the flanks where the lens meets the substrate. For many optical technologies, like white light interferometry, this large angle causes missing data points. The MarSurf CM confocal technology is able to capture and process even the extremely weak reflection signals from these steep lens flanks.

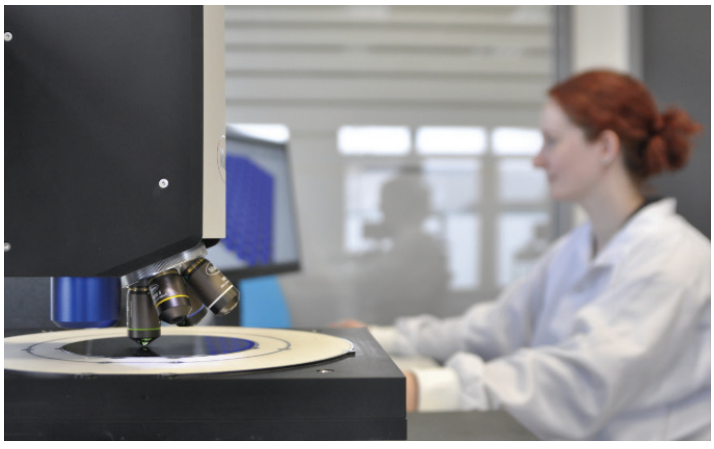
This confocal advantage combined with optimized hardware, like the high numerical aperture (NA 0.95) objective lenses and the high dynamic range camera (16 Bit HDR CMOS camera), make interpolation-free measurement of these steep flanks possible.

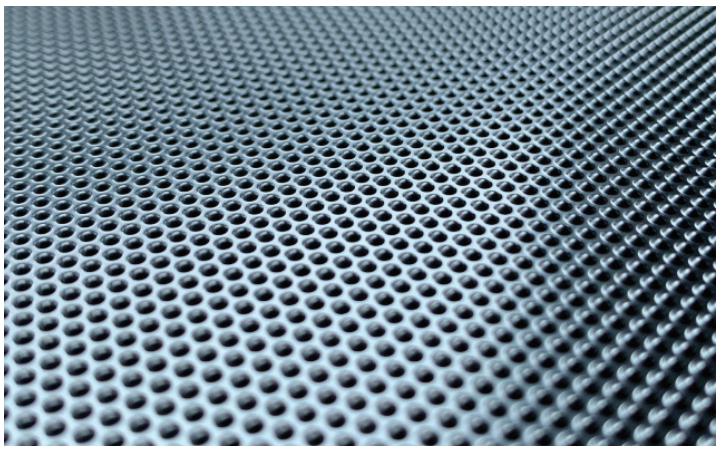


Other technologies **Mahr Confocal**

100% inspection needs high speed automatic measurements

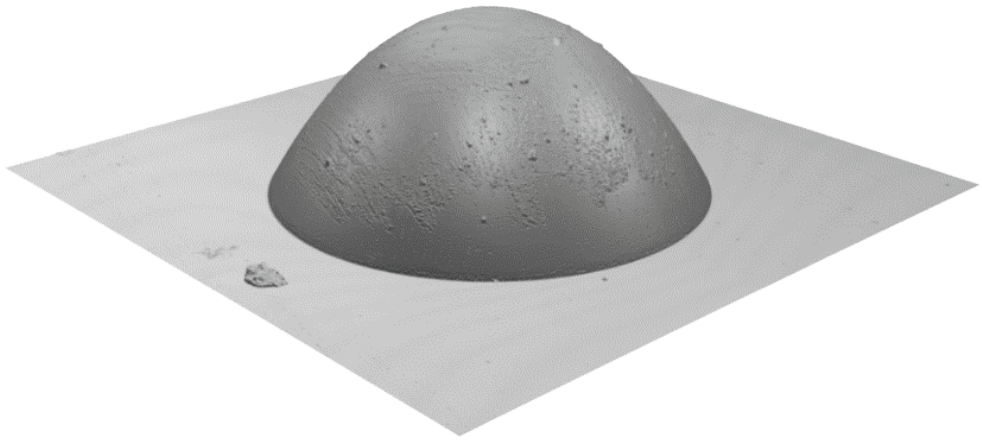
The capability to measure 100% of each micro-lens without data drop-out is only the starting point. Due to the important role that micro-lenses play in the performance of a range of optical assemblies, 100% inspection is often required. The MarSurf CM patented confocal multi-pinhole-disc sensor design combines an extremely low noise level with an extremely fast data acquisition process. The system is capable of measuring a single lens in less than 4 seconds, including positioning. Using Mahr's automatic measurement software package, 1000 lenses can be measured in just over an hour!





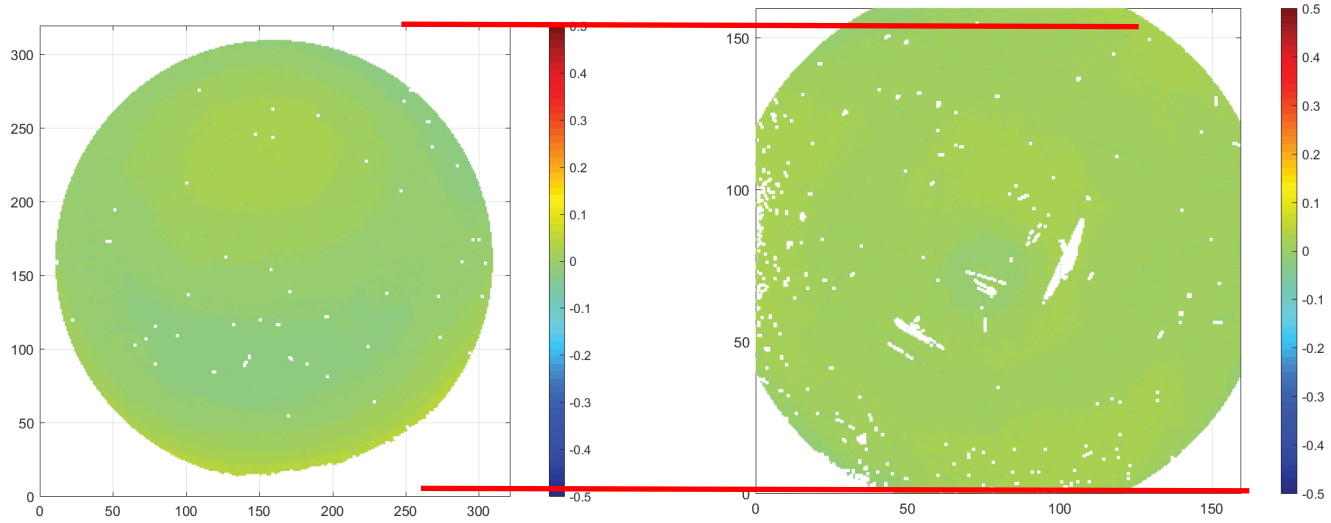
Differing manufacturing techniques require material independence

Depending on the performance requirements for the micro-lens application, different materials can be used in the micro-lens manufacturing processes. Injection molded polymers, photo-resist on glass and silicon wafers are all possible options for micro-lenses. The performance of other optical metrology instruments will be inconsistent across this range of materials. The high dynamic range and excellent sensitivity to very weak reflected light signal make the MarSurf CM technology well suited to working with a broad range of materials.



The most important factor: data quality

Coverage, speed and material independence provide no real advantage in metrology applications unless the captured data is reliable enough to be used when making technical decisions. To ensure that the MarSurf CM provides a data quality high enough to be used for micro-lens measurements, a special calibration technique is used with METAS certified ruby spheres.



Ruby sphere with certified values:

Diameter	1.00092 mm +/- 0.04 µm
Roundness	60 nm +/- 50 nm

Measured values with 50x objective lens:

Diameter	1.0000 mm
PV	66 nm
RMS	15 nm
Clear Aperture	300 µm
Critical Angle	-17.5°

Ruby sphere with certified values:

Diameter	0.50044 mm +/- 0.2 µm
Roundness	40 nm +/- 80 nm

Measured values with 100x objective lens:

Diameter	0.5006 mm
PV	38 nm
RMS	13 nm
Clear Aperture	180 µm
Critical Angle	-21.1°

Technical data

Measurement object	
Micro-lens diameter range	0.1 mm – 4 mm
Micro-lens materials	Plastic, silicon, fused silica, glass, resist on glass/silicon
Substrates	Wafers (up to 8 in), assemblies, connectors, etc.
Acquisition time	Single lens w/ 50 µm sag ~4 s including axes positioning
Hardware	
Sensor	Confocal multi-pinhole disc 10, 20, 50 and 100x lenses (1600 µm, 800 µm, 320 µm, 160 µm square FOVs respectively)
Overview camera	Color video, FOV 10 mm x 10 mm
Stages	300 mm x 300 mm linear XY, 100 mm stepper Z (positioning only), larger available on request
Safety	Automatic collision detect and stop, E-stop button
Controller and PC	Turnkey system with electronics cabinet to house stage controllers, PC and power supply
Other	PC, keyboard, mouse, monitor and joystick included
Software	
Acquisition	MarSurf Metrology
Analysis	Mountains for Mahr (standard, extended and premium), Micro-lens Analysis Add-on: ROC, PV, RMS, K
Automation	Automatic measurement software with fiducial alignment, user management, data base, recipe programming capabilities
Metrological performance (General)*	
Vertical resolution	2 nm with 100x, 0.95 NA objective lens and monochrome 505 nm wavelength
Lateral resolution	0.30 µm with 100x, 0.95 NA objective lens and monochrome 505 nm wavelength
Flank acceptance	71.8° for smooth part with 100x, 0.95 NA objective lens
Metrological Performance (Micro-lens)**	
ROC / diameter deviation	<0.1% deviation from certified value d = 1 mm (50x, 0.95 NA) <0.1% deviation from certified value d = 0.5 mm (100x, 0.95 NA)
RMS max	<20 nm (50x, 0.95 NA) <15 nm (100x, 0.95 NA)
PV max	<70 nm (50x, 0.95 NA) <40 nm (100x, 0.95 NA)

* As defined by the Fair Data Sheet Initiative
** From measurements of METAS certified ruby spheres. Diameter 1.00092 mm (+/- 0.04 µm) and 0.50044 (+/- 0.2 µm). Using 50x 0.95 NA & 100x 0.95 NA objective lenses.

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