



OPTICAL 3D SURFACE METROLOGY

INFINITE**FOCUS**

alicon**a**

## OPTICAL MEASUREMENT AND

## INSPECTION WITH INFINITEFOCUS®

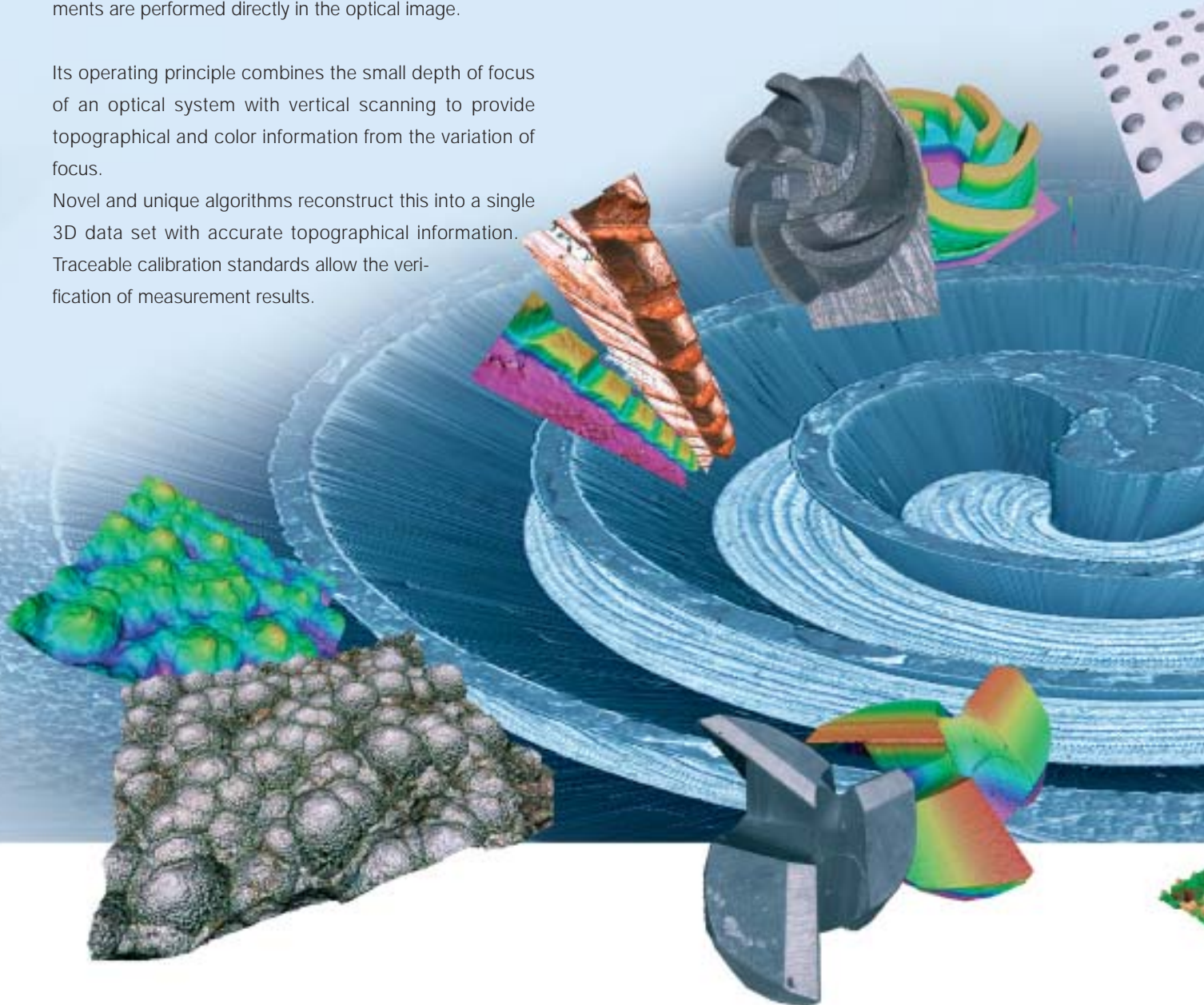
InfiniteFocus® is an optical 3D measurement device for quality assurance in the micro- and nano range. It provides all functionalities for dimensional measurements, surface analysis and characterisation. Geometries with steep flanks, highly reflective properties and strong roughness are measured with a vertical resolution up to 10nm, making the instrument ideal for surface study of both homogeneous and compound materials. 3D measurements are performed directly in the optical image.

Its operating principle combines the small depth of focus of an optical system with vertical scanning to provide topographical and color information from the variation of focus.

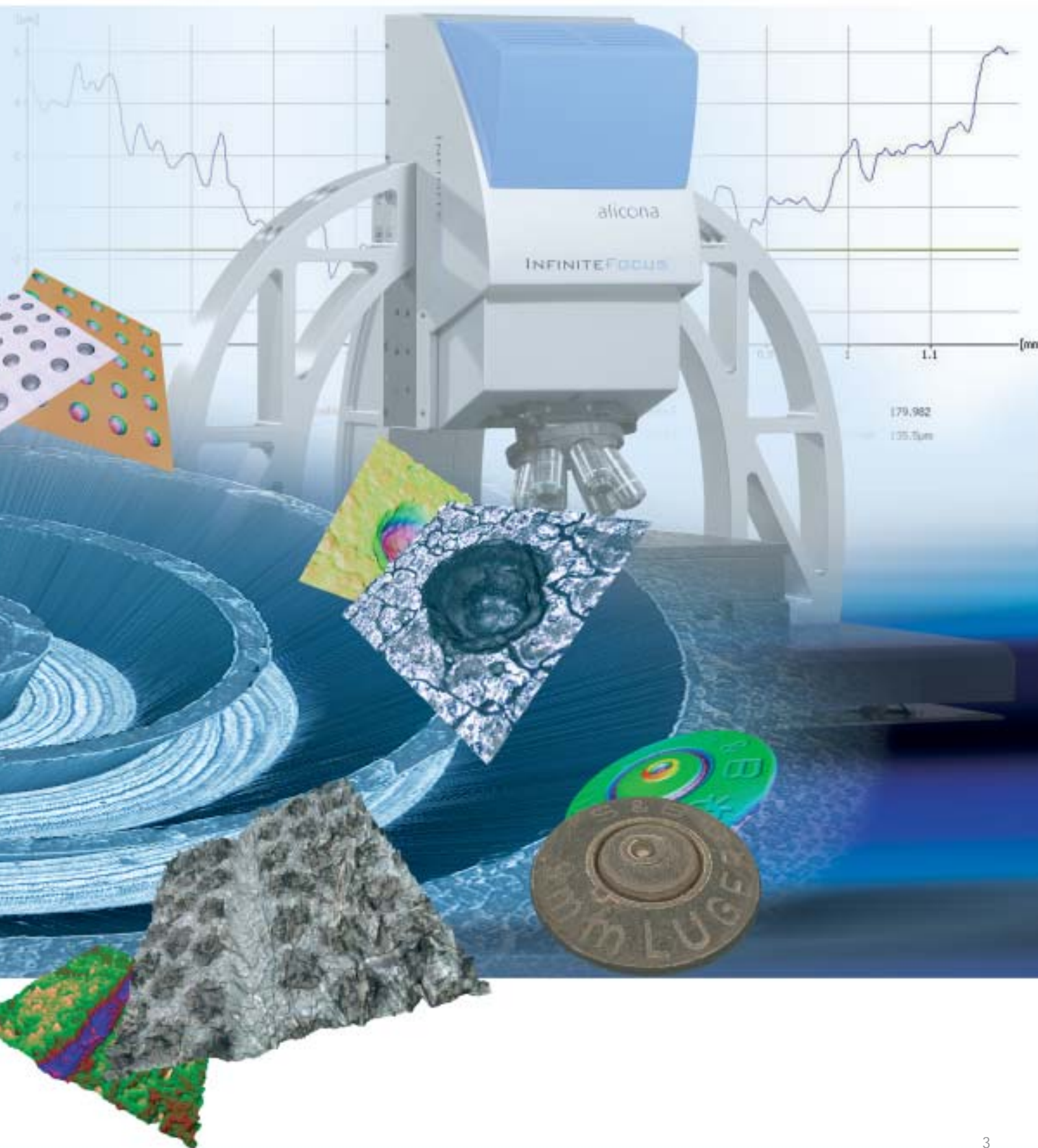
Novel and unique algorithms reconstruct this into a single 3D data set with accurate topographical information.

Traceable calibration standards allow the verification of measurement results.

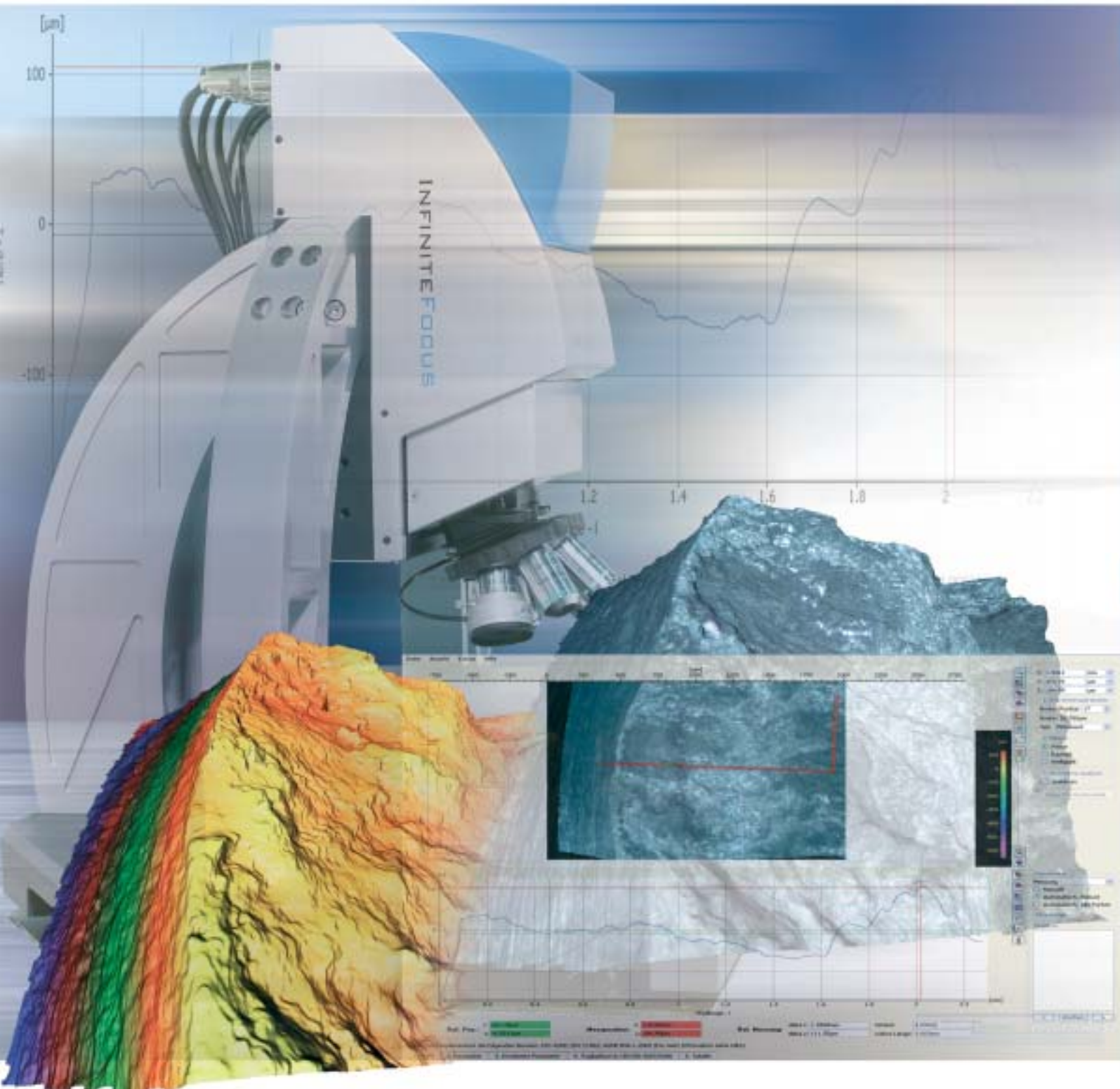
The instrument can be used in both the laboratory and during production, it can also be operated by semi skilled technicians where required. Automation of functions and analysis can also be added to make the instrument useable for the majority of surface metrology and inspection requirements.



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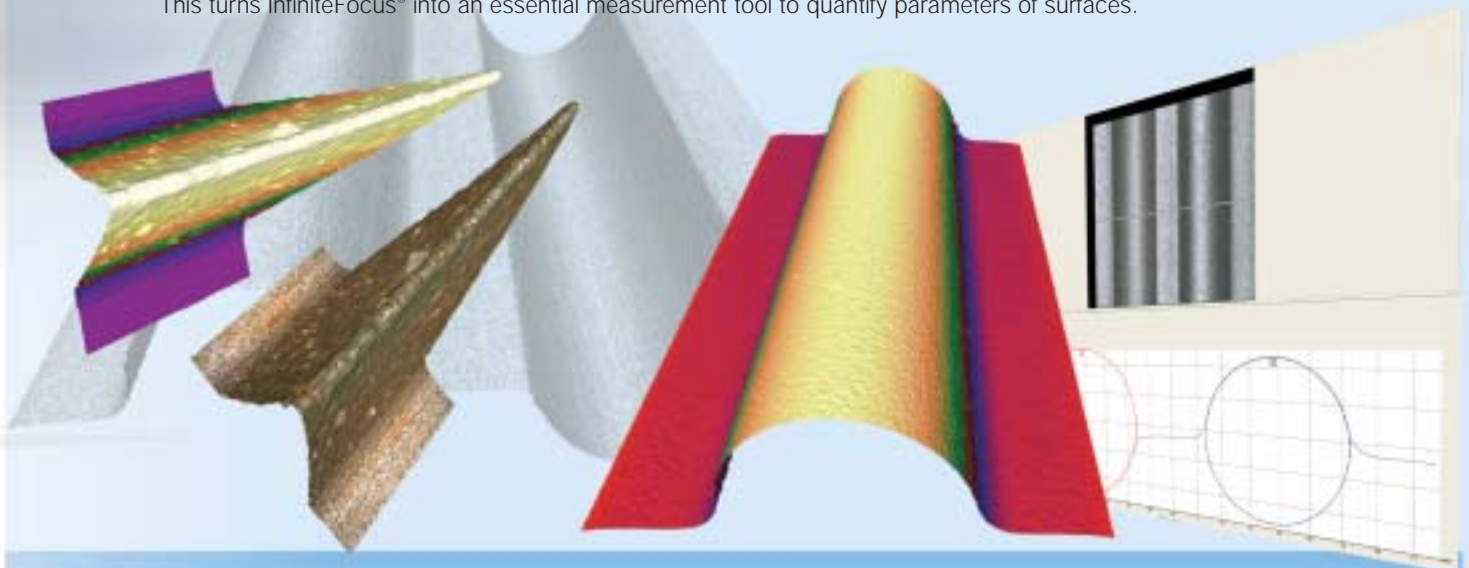


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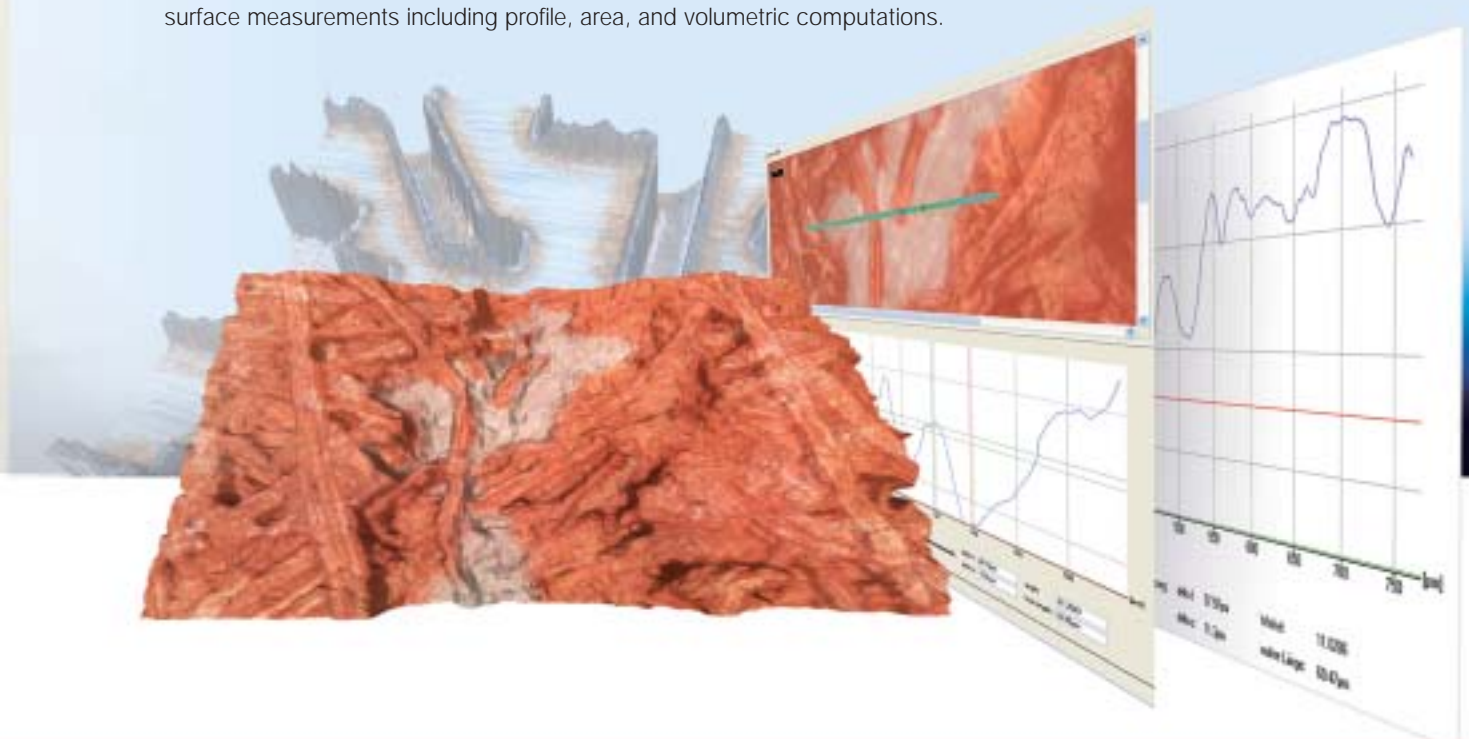
## Steep sided flanks

Surfaces often contain steep flanks and vertical edges. These structures are difficult to measure using conventional optical methods. InfiniteFocus® allows dense and robust measurements exceeding 80°. Features several millimeters deep are robustly and traceably captured. Measurement results are able to be reproduced with a vertical resolution of up to 10nm. This turns InfiniteFocus® into an essential measurement tool to quantify parameters of surfaces.



## Registered true color information

InfiniteFocus® is the only 3D measurement instrument that simultaneously captures the entire surface topographic information in combination with its true color information. Both the topographic and color information are registered to the 3D data file. 3D measurements can be performed directly on the optical color image. This visual link between the surface and its 3D information makes measurement far more precise and flexible. The straightforward user interface assures high-accuracy surface measurements including profile, area, and volumetric computations.



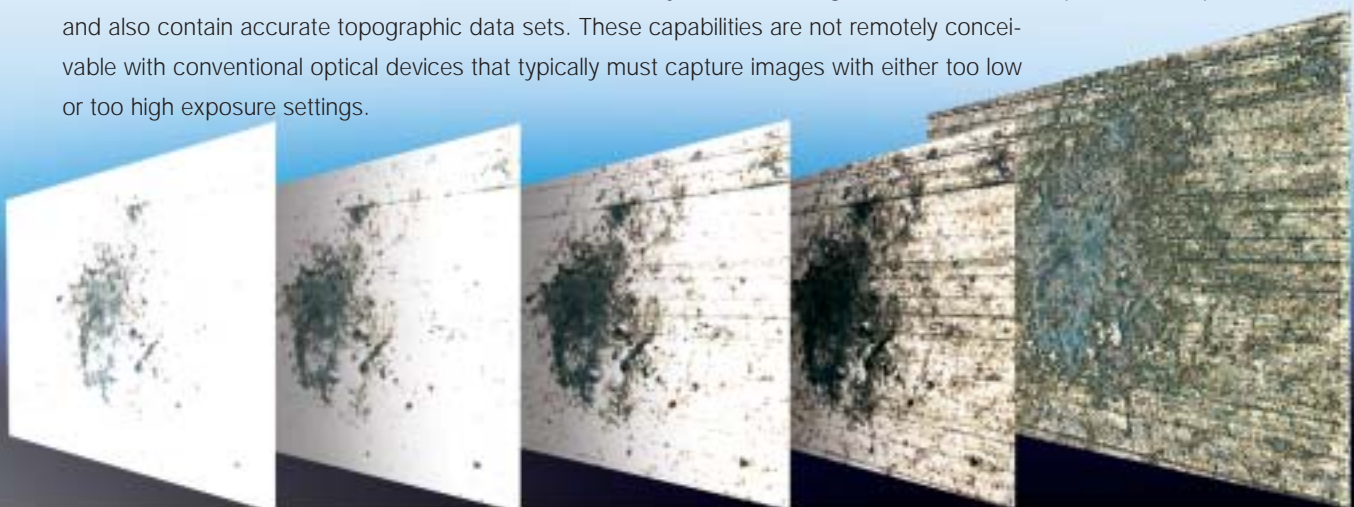
## Rough surfaces

Rough surfaces or complex form geometries are challenging for tactile and conventional optical instruments. Tactile methods can produce errors caused by the tip radius of the stylus which can cause mechanical misrepresentation of the true surface. The complex reflective properties of extremely sculptured surfaces can be extremely difficult to resolve and capture with conventional optical systems. This type of surface can be easily quantified with InfiniteFocus® enabling the accurate measurement of Ra, Rq and Rz including bearing ratio curve. Measurement of roughness, waviness and contour conform to recognized international ISO standards.



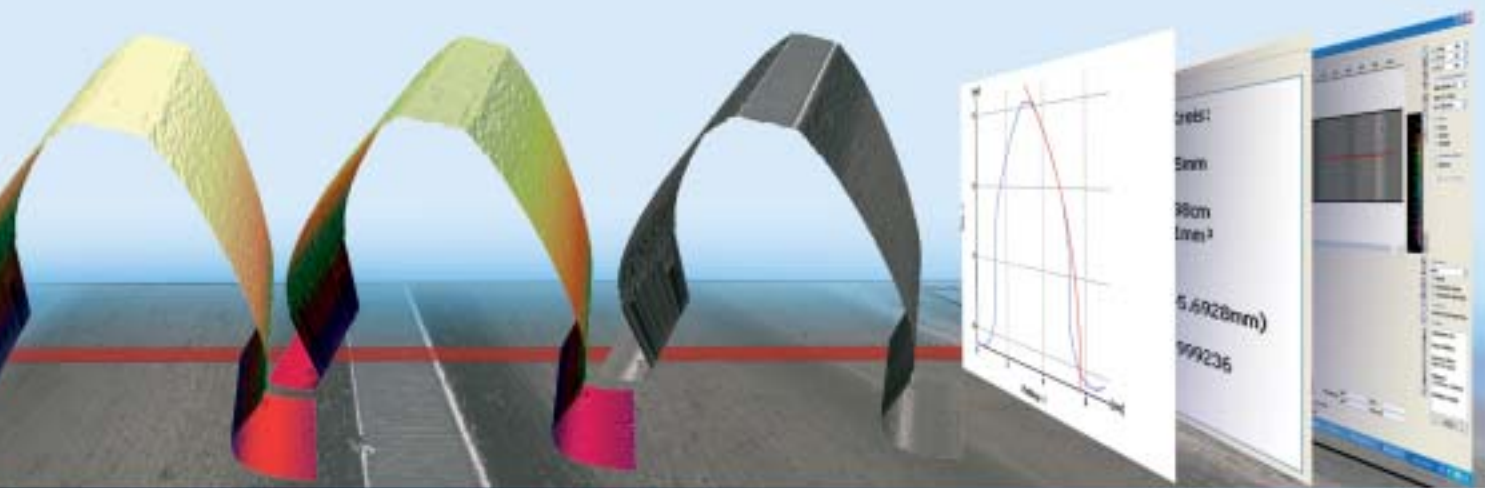
## Reflective geometries

Different surface compositions and strong topographies produce strong reflections, interreflections, and under-reflected properties. Due to the robust Focus-Variation technology, InfiniteFocus® effectively captures spectral variation between over-illuminated and under-illuminated surfaces in a radiometrically-balanced image. Results are well exposed in all specular areas and also contain accurate topographic data sets. These capabilities are not remotely conceivable with conventional optical devices that typically must capture images with either too low or too high exposure settings.



## High vertical resolution dynamic

Using conventional optical measurement techniques a high vertical resolution can only be reached with a small vertical scanning range. The robust SmartFlash® - technology of InfiniteFocus® allows a yet unknown vertical resolution dynamic and provides a high resolution even at a scanning range of several millimetres. With InfiniteFocus® a dynamic of up to 1:400000 is easily reachable, which is an essential requirement to realize robust and dense measurements of relatively large geometries.

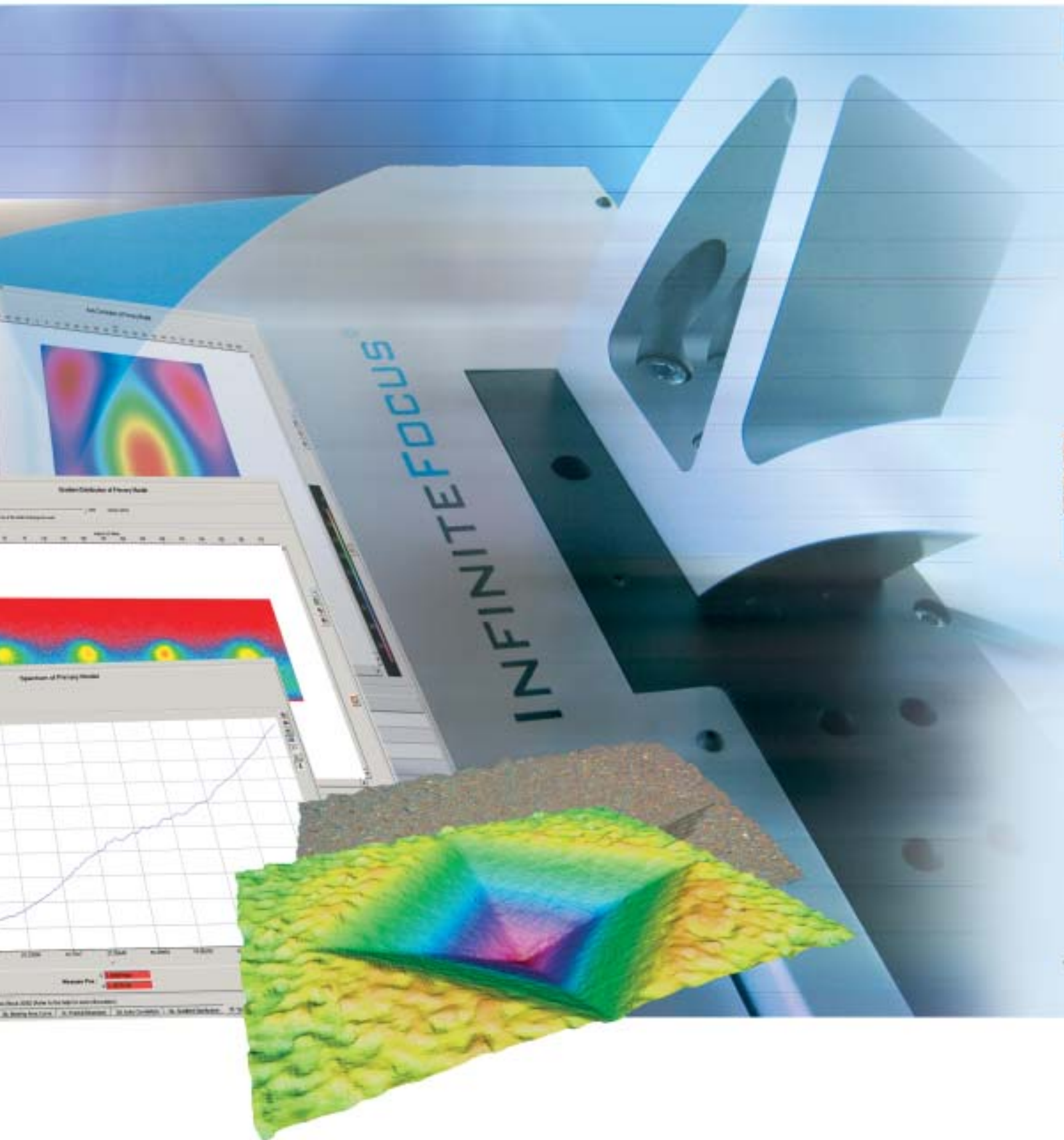


## InfiniteFocus® Inline

The InfiniteFocus® sensor uses the core components of the optical system to offer a very robust optical sensing unit. It is fitted with a strain resistant plug and drag chain, and suitable cable, to allow the easy adaptation of the sensor into a production environment. Due to the SmartFlash® illumination technology vertical measurement speeds of up to 2,5 mm per second, even over large measurement areas, can be reached. This leads to a significant increase of clock rates and makes the InfiniteFocus®-sensor an effective inline measurement system.



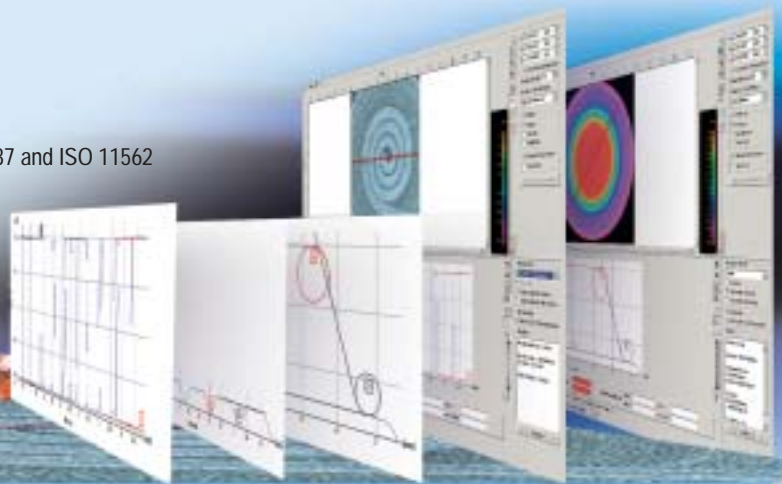
COMPREHENSIVE ANALYSIS CAPABILITIES FOR SURFACE MEASUREMENT AND CHARACTERIZATION



## Profile Analysis

Profile measurement enables the virtual cutting of a specimen. The user defines a path on the optical color image and receives the corresponding 3D profile. Roughness and contour measurements conform to recognized international EN ISO standards. The profile analysis also allows the fitting of primitives such as circles, angles or others. Further, manual and semi-automatic measurement possibilities are provided.

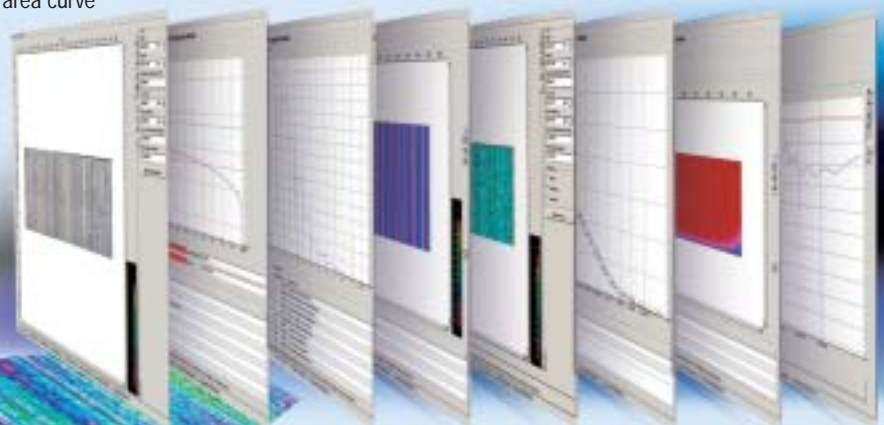
- Profile extraction with different width
- Filtering of the profile with selectable Lc value with ISO 4288 conformity information
- Manual cursor measurement
- Roughness and waviness parameter according to ISO 4287 and ISO 11562
- Calculation of fourier spectrum of profiles and bearing ratio curve
- Calculation of statistical parameters of profiles
- Calculation of mean and standard deviation of profiles



## Area Analysis

Area analysis provides comprehensive and significant measurements to classify the roughness of a surface. Also, analysis includes information about gradient and spectral distribution. The ROI (region of interest) is selected directly in the optical color image and measurements are yield fast, fully automatic and robustly. For the visual representation of the surface a grey scale or pseudo colored depth map can be used.

- Analysis of height-distribution
- Calculation of area material ratio and bearing area curve
- Measurement of spatial parameters with auto correlation function, fourier spectrum and miscellaneous parameters
- Gradient distribution
- Calculation of bearing ratio curve and bearing area curve
- Calculation of fractal dimension
- Filtering of profiles

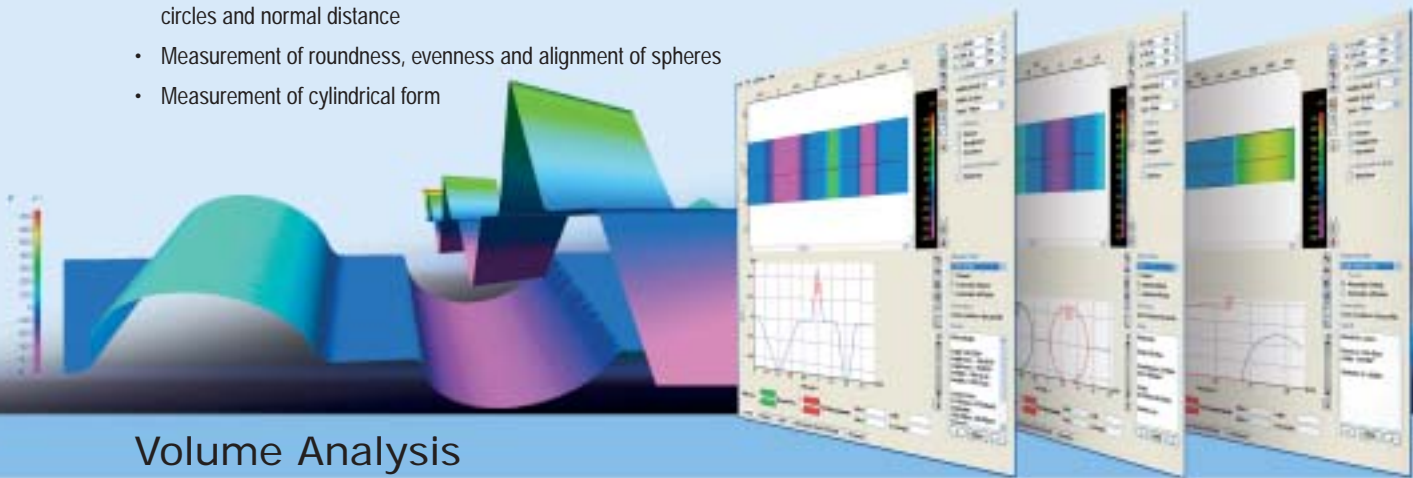


## Form Analysis

In addition to common surface analysis and characterization, InfiniteFocus® also measures complex geometries of components. Alignment of references, and measurement of surface features such as angles, radii etc. are measurements that are achieved using InfiniteFocus®. Also, even more complex surface features such as spheres can be measured and aligned.

Features Include

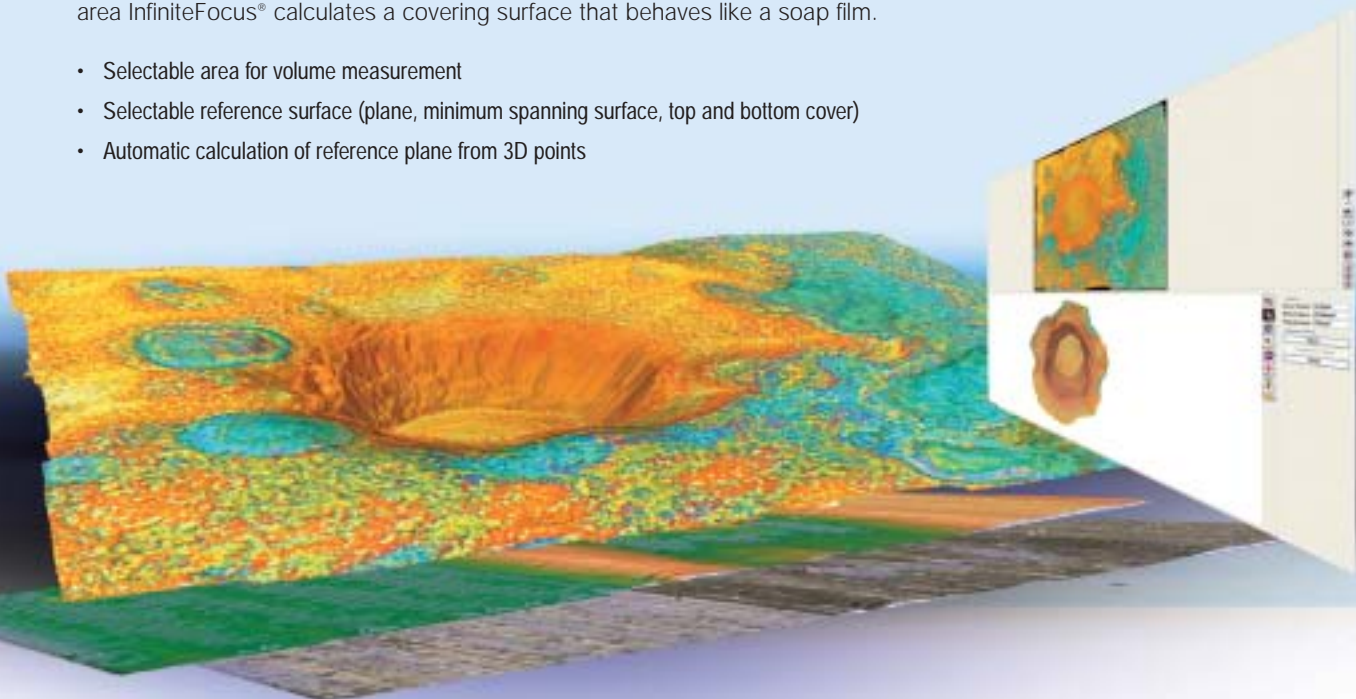
- Automatic measurement of lines, parallel lines, height steps, double height steps and ISO 5435 conform height steps, angles, 2-line-angles, circles and normal distance
- Measurement of roundness, evenness and alignment of spheres
- Measurement of cylindrical form



## Volume Analysis

Volume analysis calculates the volume of voids and protrusions. The measurement area is defined directly on the optical color image. The volume is determined throughout the computation of a soap film model. For the 3D-boundary of the selected area InfiniteFocus® calculates a covering surface that behaves like a soap film.

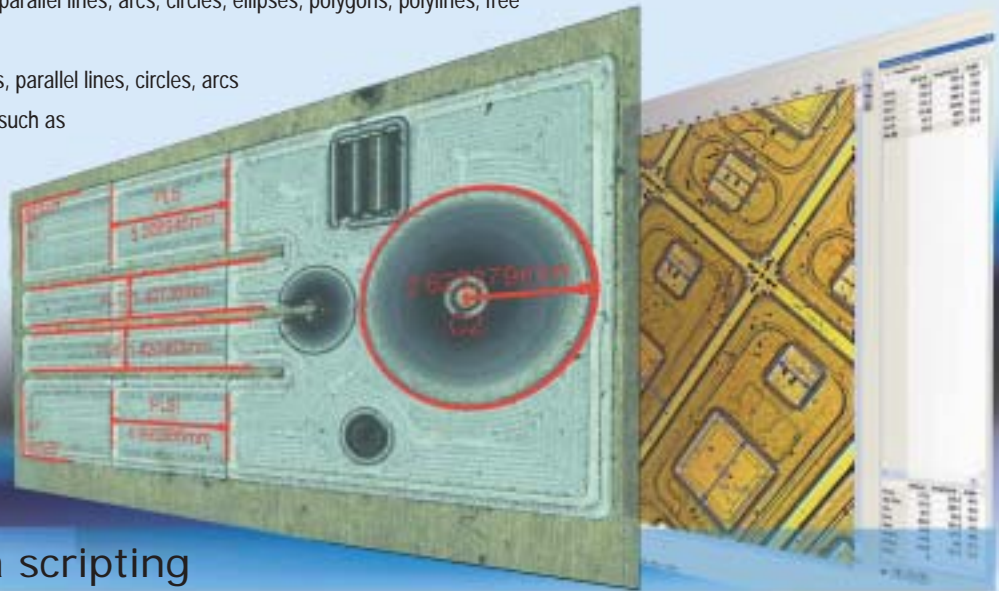
- Selectable area for volume measurement
- Selectable reference surface (plane, minimum spanning surface, top and bottom cover)
- Automatic calculation of reference plane from 3D points



## 2D Image Analysis

The 2D image analysis allows the performance of manual and semi automatic measurement of simple primitives. Also, the ability to write on the images as well as saving measurement results in a comprehensive and easy to use database is provided.

- Manual measurement of lines, parallel lines, arcs, circles, ellipses, polygons, polylines, free hand, marker
- Automatic measurement of lines, parallel lines, circles, arcs
- Statistical calculation of results such as mean, standard deviation, minimum, maximum, median
- Automatic search of equally shaped structures on the image

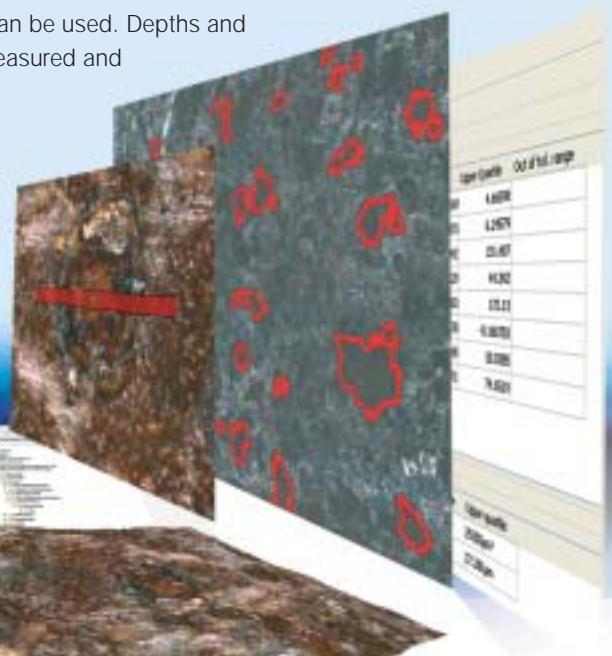


## Automation via scripting

Periodic and complex measurement tasks can be automated fast and easily. The experienced user programs InfiniteFocus® in a simple syntax similar to Java Script and can easily adopt the system to his specific needs. Resulting analysis modules can then be operated by semi skilled staff.

Automatic surface defects analysis is one example how scripting can be used. Depths and valleys as well as cracks, holes and other features are scanned, measured and quantified automatically.

- Easy to perform and fast automation of measurement tasks via scripting
- Simple programming by user or Alicona
- Statistical evaluation of measurements
- Comprehensive and user oriented help



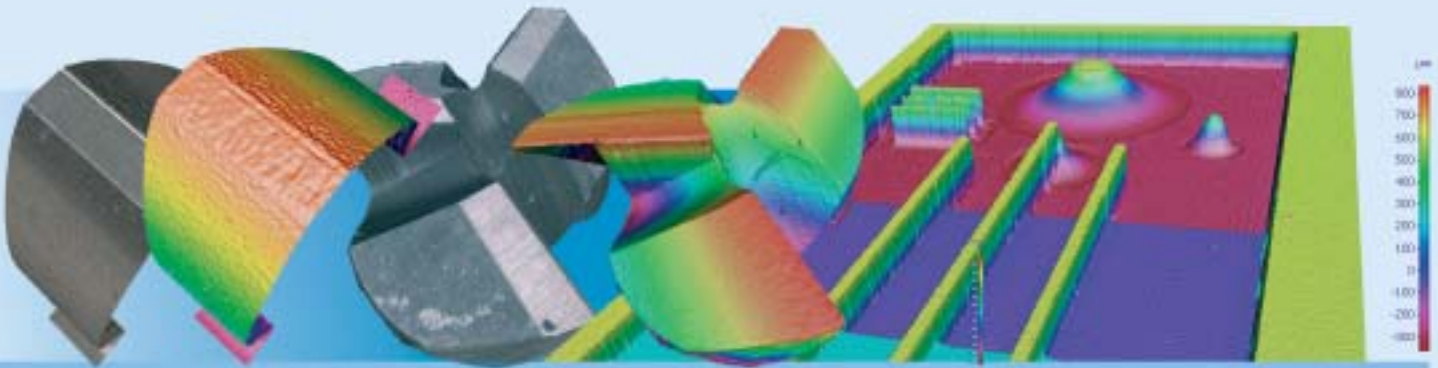
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## Geometry measurement in tool and mold making

In all tool making processes the reliable form- and geometry measurement of highly reflective components is a crucial demand. InfiniteFocus® allows complex details such as steep flanks, cutting angles and cutting edge radii to be quickly and reliably measured irrespective of reflectivity. Even over large areas with a high vertical and lateral scanning range or complex geometries such as circularly milled components and tool-tips, InfiniteFocus® yields robust surface measurement. Also, due to the use of an additional rotation system parameters such as circular spacing and release angle or other production relevant parameters in milling and drilling processes are measured.



## Automatic inspection of welding spots during production

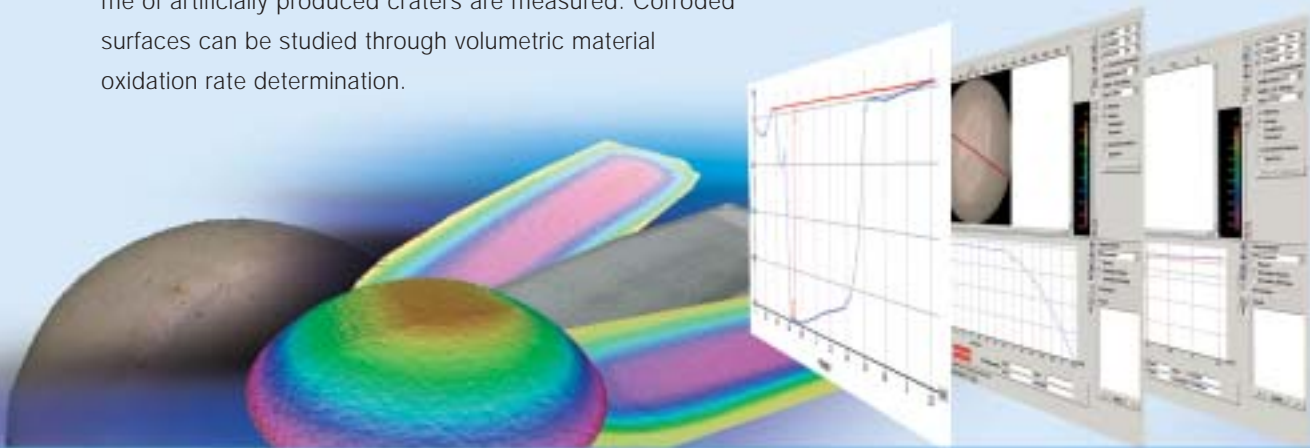
In welding processes, the optical 3D measurement device InfiniteFocus® is used to automatically measure and classify welding spots and soldering joints during production. The inline surface inspection is performed in seconds and saves costly rework.

A 100% inspection and automatic classification with go/no go status is achieved through robust surface measurement. This can be achieved across the geometry of the whole spot including steep flanks, complex reflection properties and scale caused by burning. To define go/no go parameters such as irregularities due to scaling, topography is measured including the fully registered 3D color information of the welding spots' topography. This unique combination of robust topographical data and true color information provides the go/no go data for weld classification plus advanced metrology information. This detailed information allows advanced quality assurance as scaled patches are easily identified, quantified and measured. InfiniteFocus® is also used for the 3D measurement of pins and pads.



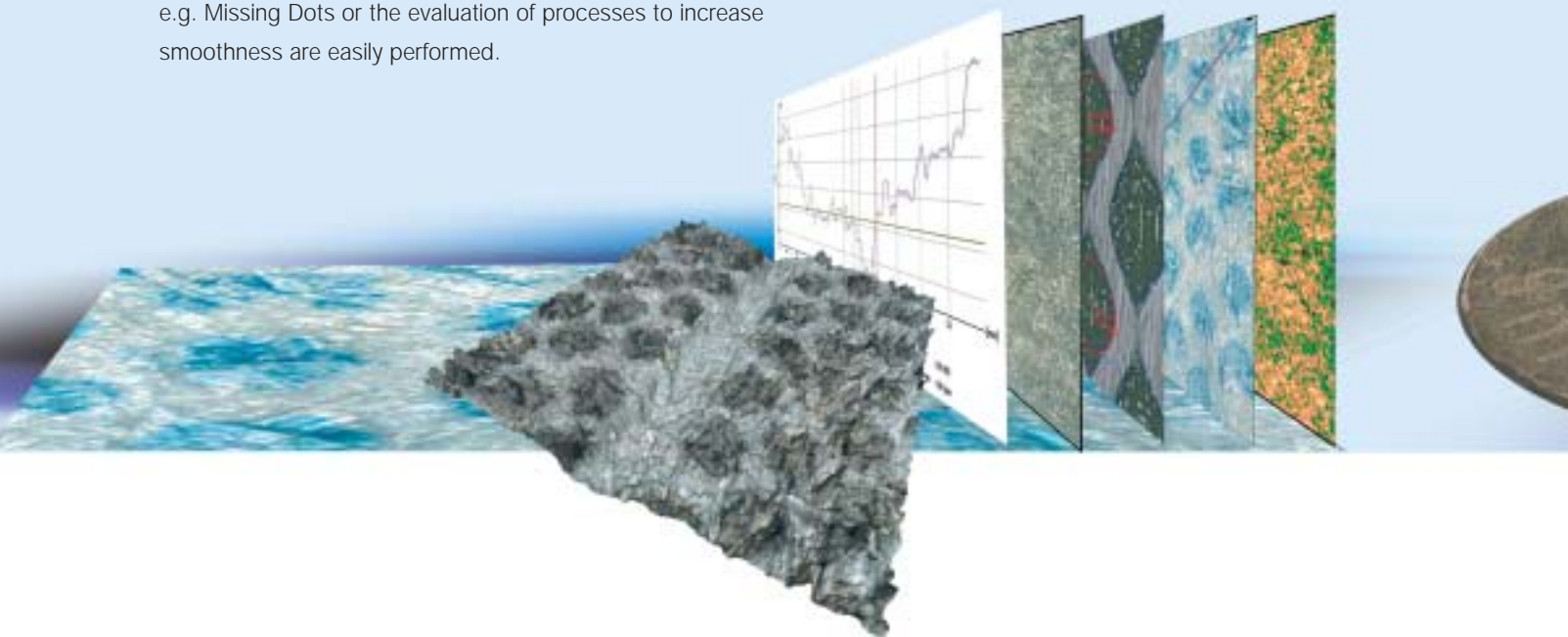
## 3D Analysis in tribology

The understanding of tribological processes such as friction and wear analysis is essential for the optimisation of many mechanical processes. In contrast to conventional methods, which are based on the analysis of 2D data, InfiniteFocus® provides numerical quantification and detailed 3D surface characterization. In e.g. wear analysis, the optical system allows easy and reliable abrasion measurement of thin coat. Depth, thickness of the coat as well as the true wear-volume of artificially produced craters are measured. Corroded surfaces can be studied through volumetric material oxidation rate determination.



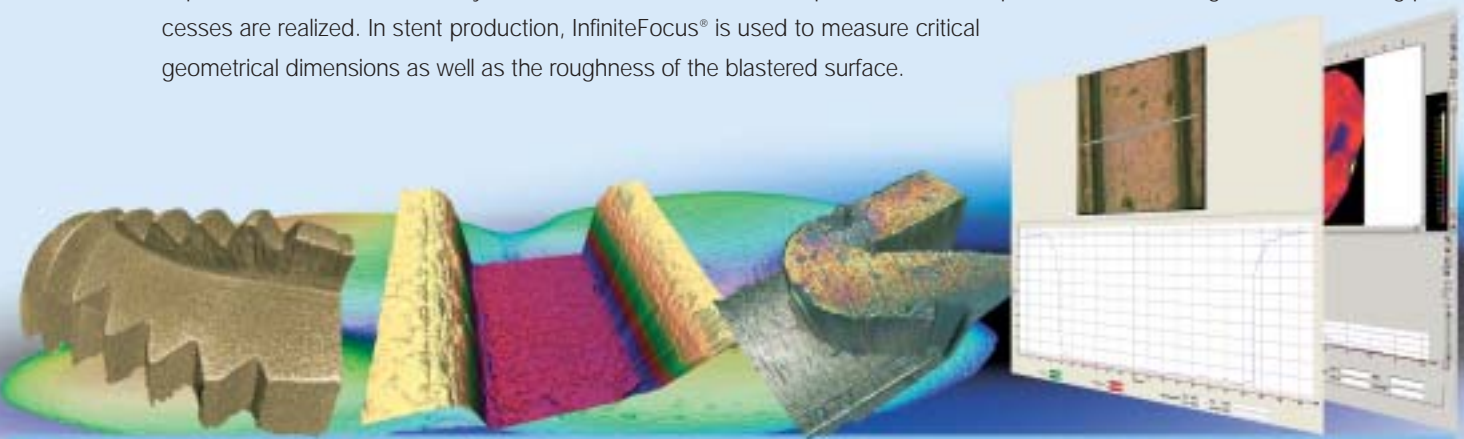
## Direct surface measurement in paper industry

The papers' topography is one of the most important parameters and a deciding factor in terms of printability. As it is with surface parameters such as height and depth, the smoothness of the paper is decisive for a high quality print image. Conventional measurement techniques such as PPS or Bendtsen are indirect methods without any numerical information about the real surface state. InfiniteFocus® is not only a direct surface measurement tool, but it also captures the entire surface topographic information registered with its true color information. So, direct correlation to its printability is provided. Various applications such as studies of poor print images showing e.g. Missing Dots or the evaluation of processes to increase smoothness are easily performed.



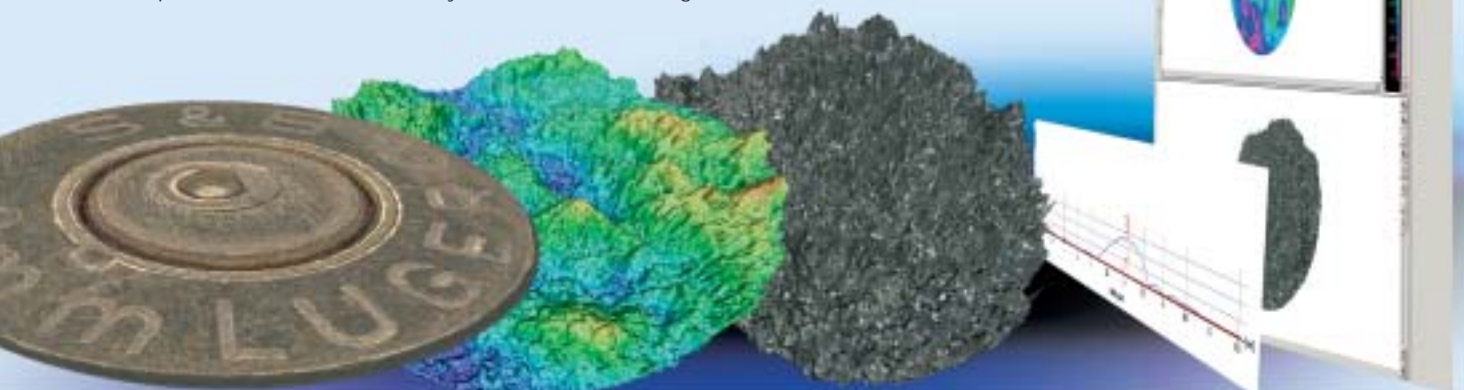
## Quality assurance in medical device development

InfiniteFocus® provides unique solutions to various medical device applications. In pharmaceutical tablet manufacturing the optical system is utilized to inspect tablet surface deviation and counterfeit surface registrations with its full 3D surface scanning capability. The flexibility and wide range of measurable surfaces also make InfiniteFocus® to a valuable quality assurance tool in medical device manufacturing. In dental medicine, the system is used for roughness measurement and to verify the geometry of implants. Also, tooth wear analysis and advanced measurement performances to optimise various drilling and laser ablating processes are realized. In stent production, InfiniteFocus® is used to measure critical geometrical dimensions as well as the roughness of the blasted surface.



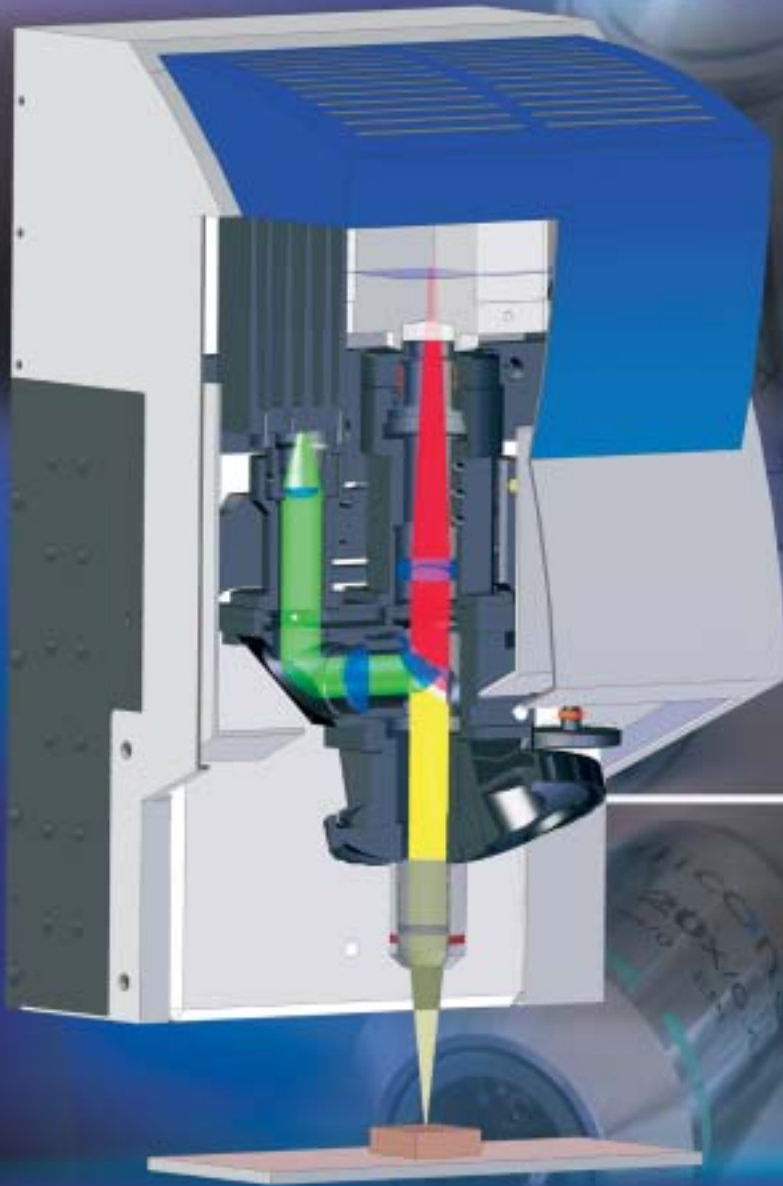
## Materials Science and Failure Analysis

Conventional microscopy inspects the surface optically with light microscopes and is limited by the microscope's depth of focus. Quantitative surface information must be obtained by a separate 2D or 3D surface analysis instrument. Since specimens in material development often contain fractured surfaces with steep flanks or rough surface topography, InfiniteFocus® offers a unique solution to document the entire surface. The analysis of the optical appearance of the surface coupled with the topographic data is directly correlated to the reconstructed 3D color image. Fatigue fracture analysis and material deformation at ductile fracture zones can be easily quantified through volumetric, area, or profile measurements directly on the true color image.



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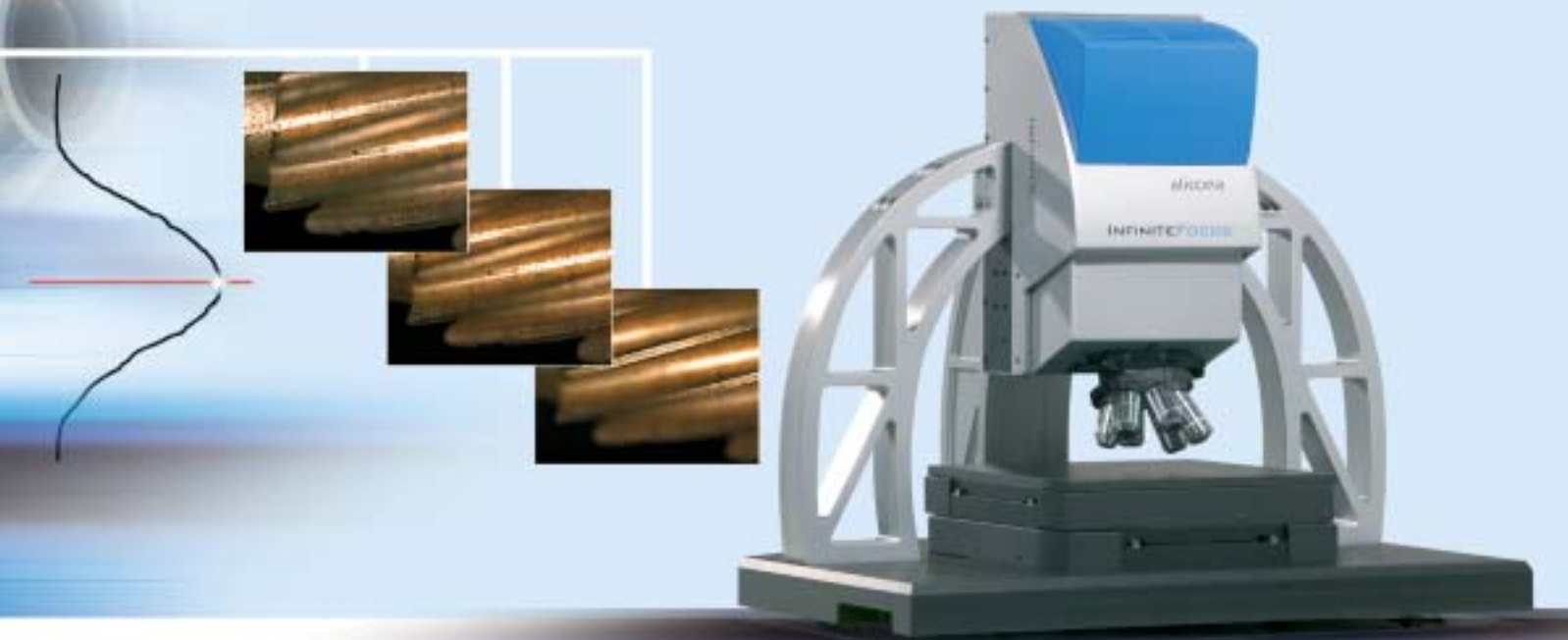
## The Operating Principle of InfiniteFocus®

The technique of InfiniteFocus® is based on Focus-Variation. Its operating principle combines the small depth of focus of an optical system with vertical scanning.

The specimen is placed onto the motorized stage and is illuminated with modulated white light. The coaxial white light is provided by a light source delivered through a beam splitter to a series of selectable, infinity-corrected objectives contained in a six-place nosepiece. The specimen's reflected light is projected through the beam splitter onto a color digital sensor.

The selection of both, vertical and lateral resolution can be realized through a simple change of objectives. The resulting image is similar to conventional light microscopy in a way that it shows limited depth of focus. As the distance between the object and objective is varied images are continuously captured. Each position in depth is differently imaged depending on the 3D structure of the specimen. The harmonized interaction between modulated illumination, vertical scanning and sensor capturing is crucial for this process. The innovative Alicona SmartFlash® technology realizes this interaction. For each position on the object sharpness is calculated. The variation of sharpness is now utilized for extracting depth information. A dense 3D surface representation of the object is obtained.

The operating principle Focus-Variation has been added to the latest ISO standard for classifying surface texture methods. The new ISO norm 25178 for the first time includes standardized parameters to classify optically area based measurements. As an official member of the responsible ISO committee, Alicona contributes in defining the classifications of methods for surface measurement techniques. Further standards are in work.



## TECHNICAL SPECIFICATION

### General Specification

Measuring principle:	non-contact, optical, 3 dimensional, based on Focus-Variation
Measuring result:	dense, true color surface model with 2-25M 3D points
Maintenance:	maintenance free
Illumination:	White LED coaxial light, high power, digital controlable Optional: White LED ring light, high power, digital controlable Optional: polarisation
Nosepiece:	6 objectives manual or 5 objectives motorized
Lateral travel range (XY):	100mm x 100mm
Vertical travel range (Z):	100mm
Weight:	95-100kg, depending on equipment
Temperature range:	possible: 5° - 40°C; calibrated for: 18° - 22°C (other temperature ranges can be calibrated)
Temperature gradient:	less than 1° per hour
Power supply:	900W; 100-230V~; 50-60Hz
Processor:	High performance quad chip
Memory:	4GB
Dimensions (WxLxH):	in mm: 710 x 540 x 628

### Specimen

Specimen surface texture:	Surface topography Ra above 10-15nm, depending on surface structure
Material:	any solid surface
Max. height of object:	100mm up to 240mm
Max. weight of object:	20kg, more on inquiry
Maximum slope angle:	up to 90°
Sample preparation:	none

### Objectives Details

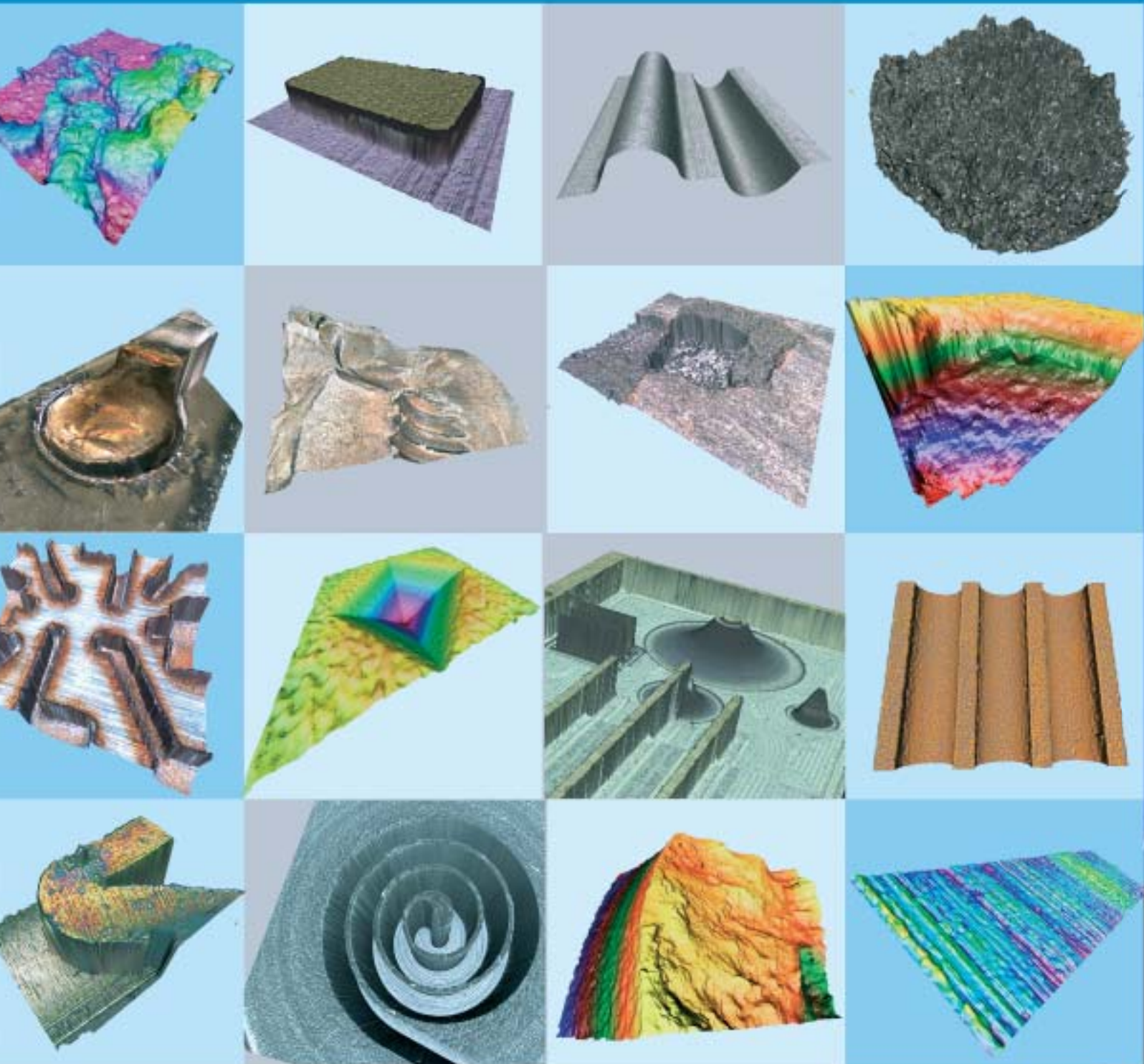
Objectives		2,5x	5x	10x	20x	50x	100x
Sampling distance	µm	3.52	1.76	0.88	0.44	0.18	0.09
Optical lateral resolution	µm	5.6	2.2	1.1	0.8	0.6	0.4
Min. vertical repeatability	µm	0.8	0.15	0.04	0.02	0.008	0.003
Max. scan height (approx)	mm	8	22	16	12	9	3.2
Vertical resolution (low speed)*	nm	2300	410	100	50	20	10
Vertical resolution (high speed)*	nm	47100	8200	2000	1000	400	200
Scan speed (low)	µm/s	20	3.5	0.9	0.1	0.1	0.02
Scan speed (high)	µm/s	400	70	17	8	4	1
Vertical dynamic		3400	52000	160000	250000	430000	380000
Working distance	mm	8.8	23.5	17.3	13	10.1	3.5
Field of view X	µm	5716	2858	1429	715	286	143
Field of view Y	µm	4351	2175	1088	544	218	109
Max. extended field of view	mm <sup>2</sup>	10000	10000	3200	800	130	35
Max. uni-directional scan extension	mm	100	100	100	100	100	100

\*) Vertical resolution can be adjusted depending on application, this also influences the scan speed.

### Software

Measurement:	Image with full depth of focus, 3D surface measurement in true and false color
Analysis:	Profile analysis (height, roughness, Ra..), Area analysis (Sa, Fractal dimension,...) Volume analysis, Image analysis (2D Measurements), 3D Editor
Automation:	IF Automation (built-in script editor), IF Remote Interface (remote control from another PC with .NET Remoting)
Visualization:	2D single and stereo image, high resolution 3D visualization, anaglyph view
Database:	intuitive, graphical database
Import/Export:	all common image formats are supported, easy export of results, various printing capabilities





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