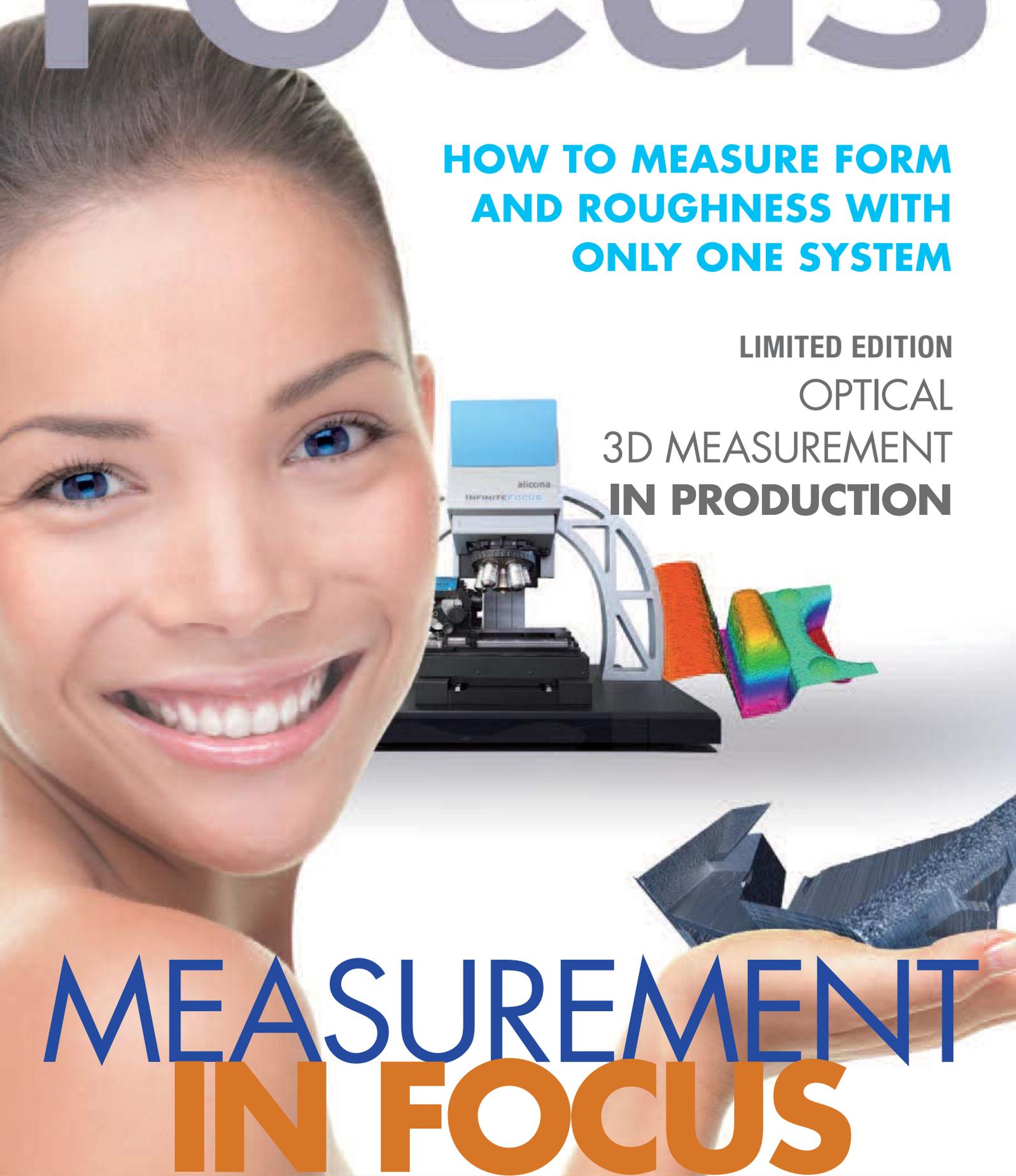


FOCUS

variation

**HOW TO MEASURE FORM
AND ROUGHNESS WITH
ONLY ONE SYSTEM**

LIMITED EDITION
OPTICAL
3D MEASUREMENT
IN PRODUCTION



**MEASUREMENT
IN FOCUS**

INFINITEFOCUS X-LARGE

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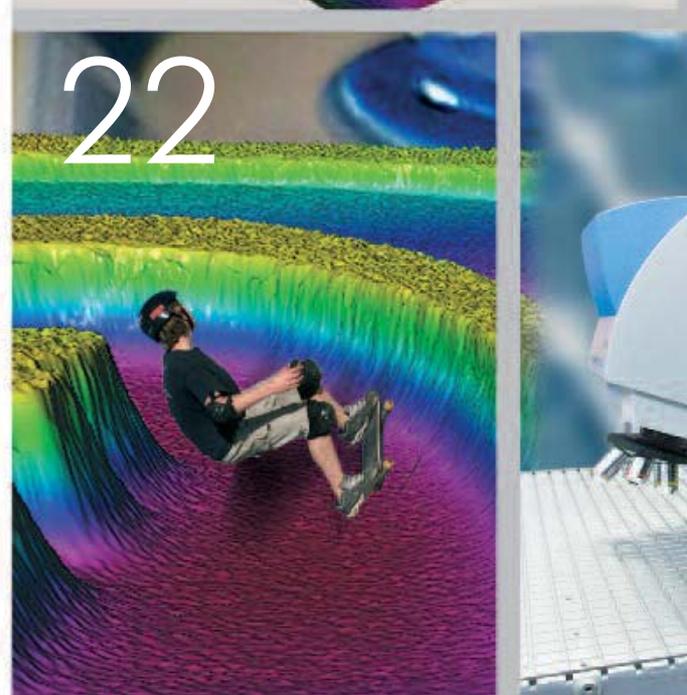
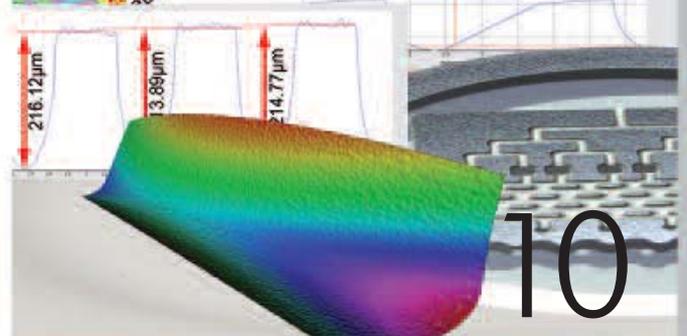
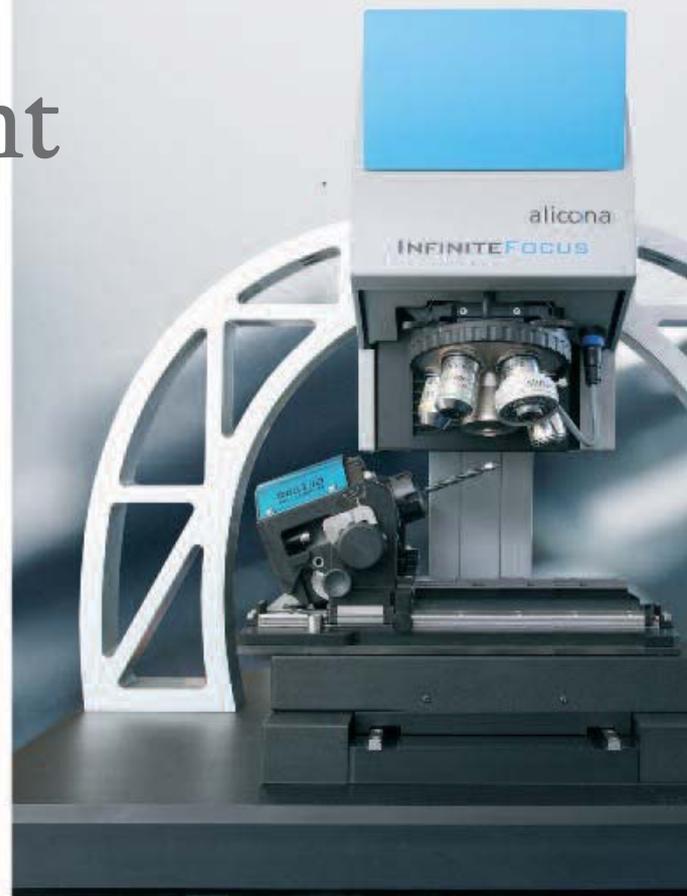
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*Dr. Stefan Scherer,
Alicona CEO*

*Dr. Manfred Prantl,
Alicona CEO*

Editorial

It is one thing to (small) talk about quality assurance, but is another thing to prove how quality assurance is performed. Manufacturers are increasingly confronted to verify product quality and quality assurance with state of the art technologies to their customers. In metrology, this means that there are technologies requested which provide reliable and reproducible measurement results and which are secondly easily adjustable to meet new applications or environments. This is followed by the demand to visualize results in a clear and attractive manner. Focus-Variation meets all these requirements – users are able to “really see” and understand what is being manufactured.

In addition to the variety of possible applications a further key feature of this high resolution measurement technique is its easy adaption to meet applications such as the measurement of micro structured surfaces of large components or roughness measurement of complex forms. In this issue of FOCUSvariation we present the InfiniteFocus X-Large series to measure large and/or heavy components with high precision accuracy.

Also, this issue is supplemented with FOCUSvariation production, which is a limited edition of FOCUSvariation that presents how InfiniteFocus is used in production. “Leave the lab and go inline” is the topic and illustrated throughout the InfiniteFocus product series for high resolution measurements also in production.

Enjoy exploring new possibilities in optical 3D metrology!

The system.

*InfiniteFocus is a **high resolution optical 3D surface metrology system for lab and production.***

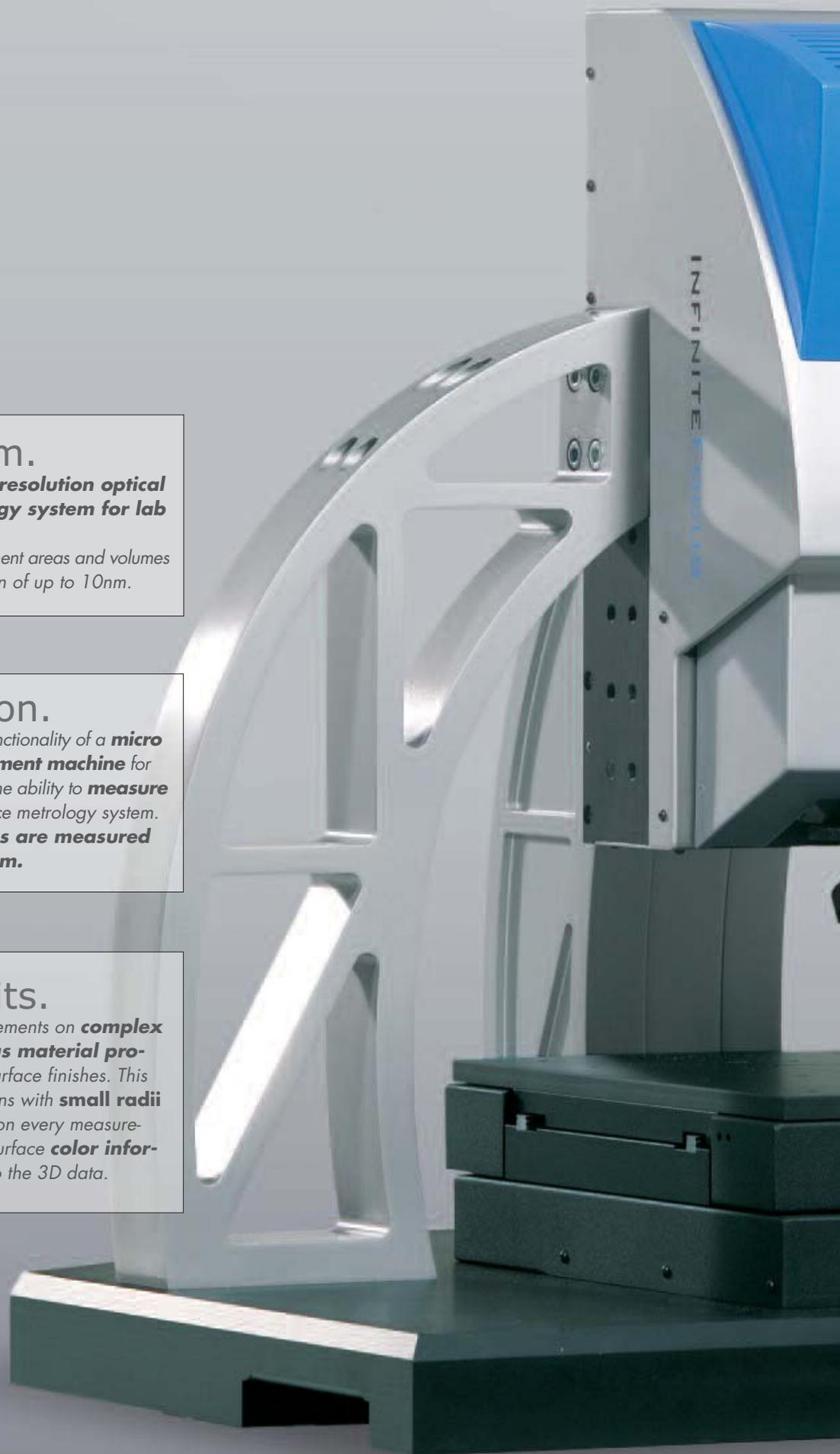
It tackles large measurement areas and volumes with a vertical resolution of up to 10nm.

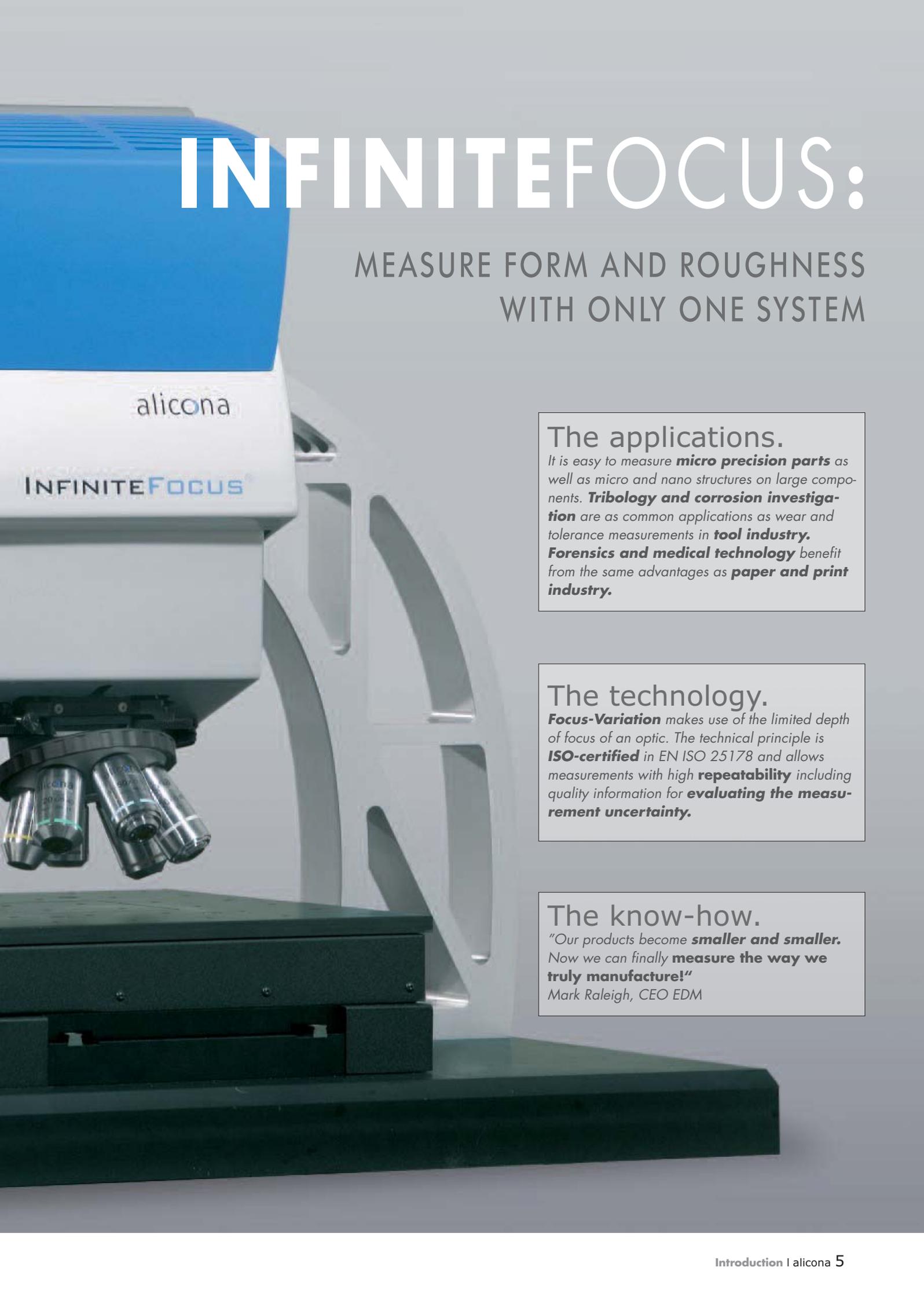
The function.

*InfiniteFocus offers the functionality of a **micro coordinate measurement machine** for form measurement and the ability to **measure roughness** like a surface metrology system. **Form and roughness are measured with only one system.***

The benefits.

*High resolution measurements on **complex components, various material properties** and varying surface finishes. This also applies to specimens with **small radii and angles**. In addition every measurement is provided with surface **color information registered** to the 3D data.*



A photograph of an Alicona InfiniteFocus microscope. The machine is primarily white with a blue top section. The brand name 'alicona' is printed in a lowercase, sans-serif font on the white part. Below it, 'INFINITEFOCUS' is written in a larger, bold, uppercase font, with 'FOCUS' in blue. The microscope's objective lenses are visible at the bottom left, and a dark green stage is at the bottom. The background is a plain, light grey.

INFINITEFOCUS:

MEASURE FORM AND ROUGHNESS
WITH ONLY ONE SYSTEM

The applications.

It is easy to measure **micro precision parts** as well as micro and nano structures on large components. **Tribology and corrosion investigation** are as common applications as wear and tolerance measurements in **tool industry**. **Forensics and medical technology** benefit from the same advantages as **paper and print industry**.

The technology.

Focus-Variation makes use of the limited depth of focus of an optic. The technical principle is **ISO-certified** in EN ISO 25178 and allows measurements with high **repeatability** including quality information for **evaluating the measurement uncertainty**.

The know-how.

"Our products become **smaller and smaller**. Now we can finally **measure the way we truly manufacture!**"
Mark Raleigh, CEO EDM

Take2 is a thing of the past.

Today form as well as roughness of a component is measured with only one technology.

Focus-Variation offers the functionalities of a micro coordinate measurement machine with those of a surface metrology system. This allows InfiniteFocus to acquire full surface characteristics since both, form and roughness is measured with only one system. Even across large measurement areas and volumes.

USE INFINITEFOCUS

- » for quantifying material characteristics on an areal basis
- » to measure functional parameters on plain or complex surfaces
- » for identifying nuances caused by a manufacturing process and defining parameters for process reliability
- » to measure fine roughness and small micro form elements



Sa 9.97µm

USE INFINITEFOCUS TO MEASURE FORM AND ROUGHNESS

Surface metrology and form measurement in one system

Focus-Variation is the technology. The result is a device measuring large areas and volumes with a vertical resolution of up to 10nm.

One system covers all

InfiniteFocus is an optical high resolution 3D measurement system for quality assurance in the lab and in production. The micro coordinate measurement machine by Alicona combines all functionalities of a coordinate measurement machine with those of a surface measurement device. This means that InfiniteFocus measures form and roughness of components with a vertical resolution of up to 10nm - even across large vertical and lateral measurement areas.

The technological edge to combine roughness and form is due to the high resolution and the very high measurement point density. More than 100 Mil measurement points enable full surface characterisation - roughness measurement in combination with form - even across large measurement areas and volumes. Also when measuring complex shapes with steep flanks and smallest radii the large point density ensures that highest resolution is achieved. This allows the measurement of dimensional accuracy on areas that have not been accessible before and, which cannot be measured by conventional measurement techniques. In addition, the Alicona SmartFlash technology ensures that InfiniteFocus automatically adjusts to the different

surface properties of a specimen. This allows the measurement of compound materials and other topographies with varying material appearance.

See where and what you measure

InfiniteFocus is the only optical measurement system to provide measurement data perfectly registered to surface color information. This really simplifies the use as the operator is much quicker in detecting a relevant spot for investigation. Due to the correlation between registered true and pseudo color view, measurements become faster and more flexible. In addition, registered surface color information enables the accurate measurement of large measurement areas.

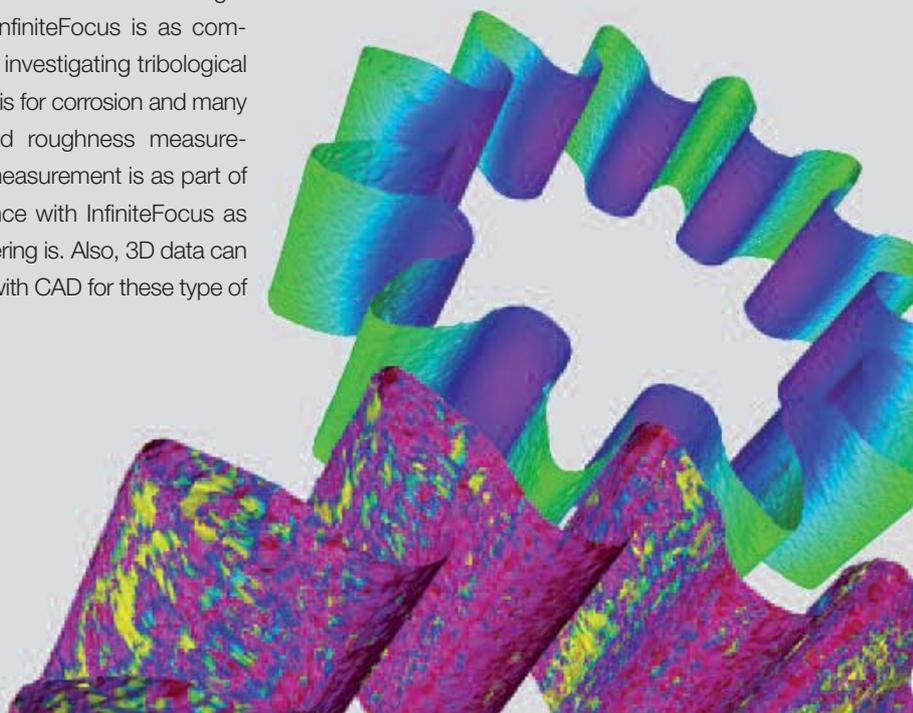
Applications

Using InfiniteFocus, smallest micro precision parts are as easily measured as micro- and nano structures on larger components. InfiniteFocus is as commonly used for investigating tribological processes as it is for corrosion and many other form and roughness measurements. Wear measurement is as part of quality assurance with InfiniteFocus as reverse engineering is. Also, 3D data can be processed with CAD for these type of applications.

The fields of application for InfiniteFocus are nearly unlimited: any solid surface with a minimum roughness of only a few nanometers can be measured. This applies to measurements in the field of tool manufacturing, micro system technology, micro fluidics, material science, medical technology, paper industry, electronics, forensics and many more.

Focus-Variation

InfiniteFocus is based on the technology of Focus-Variation. The small depth of focus of an optical system is used to extract depth information of a surface. This optical technique allows repeatable and traceable measurements - including quality information to judge measurements uncertainty. Focus-Variation is included in EN ISO 25178.





Focus-Variation is one of the most innovative optical technologies developed in present times. It is included in the most recent **EN ISO standard 25178**.

Focus-Variation allows high resolution, repeatable and traceable measurements of

- » form and roughness
- » small radii and angles on complex forms with steep flanks and across large measurement volumes
- » surfaces made out of various materials and extreme roughness



GAINED IN PRACTICE, FOR USE IN PRACTICE.

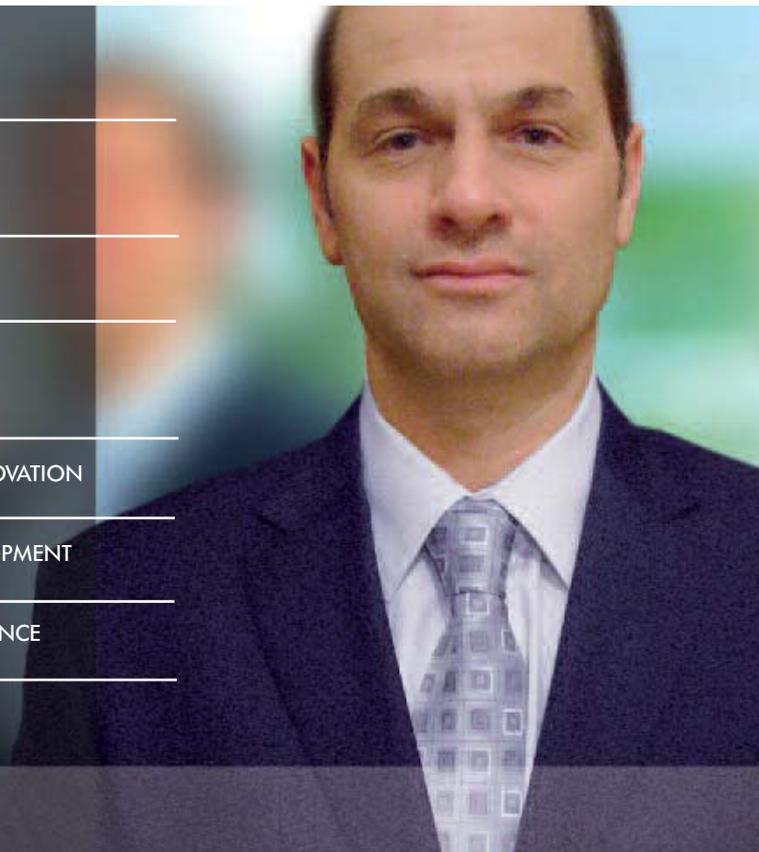
“INFINITEFOCUS IS THE KEY FOR OUR QUALITY ASSURANCE”

MARK RALEIGH IS OWNER AND CEO OF THE MICRO MANUFACTURING COMPANY EDM DEPARTMENT, BARTLETT, IL, USA. HE KNOWS INFINITEFOCUS FIRST HAND AS A USER. HIS EXPERIENCES WITH THE SYSTEM ARE SEEN AS A SEAL OF APPROVAL FOR THE OPTICAL MEASUREMENT DEVICE. FROM HIS PERSPECTIVE HE PRESENTS THE FOLLOWING UNIQUE SELLING PROPOSITIONS.

- » MAXIMIZE PROFIT
- » SIMPLIFY COMPLAINT PROCESSING
- » OPTIMIZE PRODUCTION
- » INCREASE NUMBER OF NEW CUSTOMERS
- » INCREASE DEGREE OF INNOVATION
- » SPEED UP PRODUCT DEVELOPMENT
- » ENHANCE QUALITY ASSURANCE

Mark Raleigh, CEO EDM Department

EDM Department Inc.
advanced development of
flexible manufacturing



All measurements include data registered to the object color information. 360° measurement opens up completely new views and insights.

When components are below 100µm traditional tactile methods are no longer suitable. The deeper and smaller the recesses produced by drills, micro milling cutters etc. are, the smaller is the probability that these components can be adequately measured. The EDM Department, a specialist user of hybrid manufacturing methods now uses an optical technology that starts measuring where other techniques have already reached their limits. CEO Mark Raleigh says: “Since we have integrated InfiniteFocus in our manufacturing process we know about details I have never seen or even measured before.”

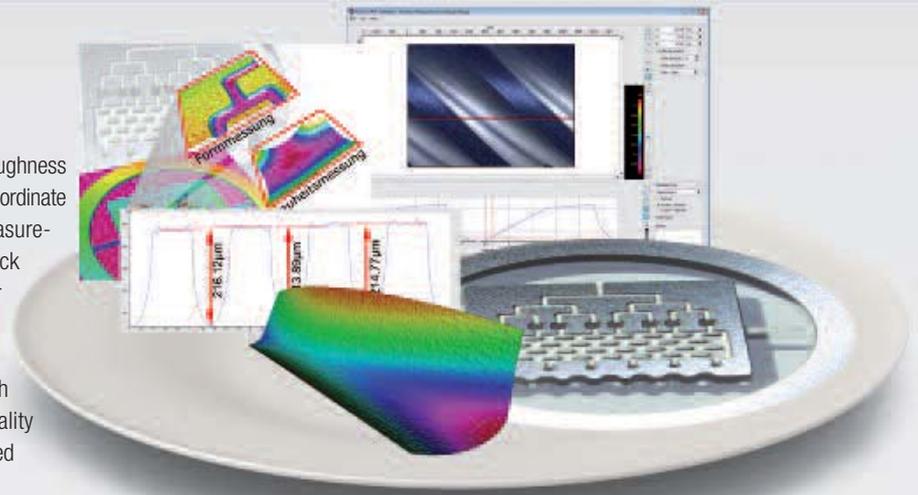
MARK RALEIGH SERVES

A FULL MENU OF

FORM AND ROUGHNESS with only one system

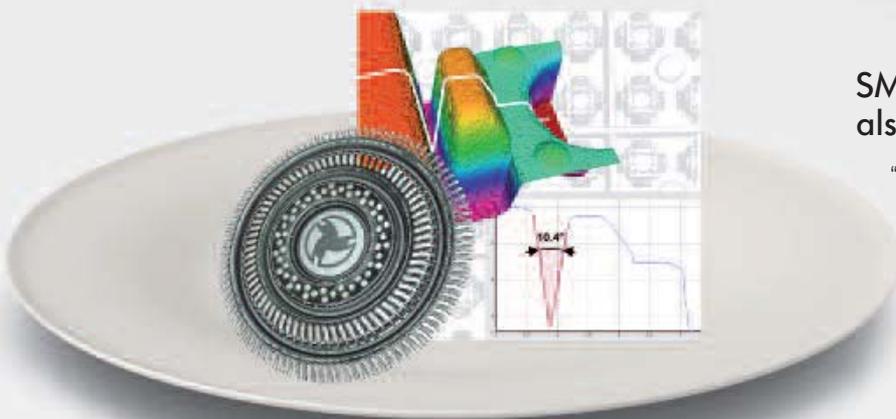
"By using InfiniteFocus we can measure form and roughness within the same measurement. Up to now, a contact coordinate measurement machine has been used for form measurements, for evaluating the accuracy of fit and to check manufacturing tolerances of our components. For roughness measurements we have been using a traditional tactile surface metrology system.

Now we have a system which covers both and which is extremely easy to use. This has simplified our quality assurance to an extent as we could not have visualized before."



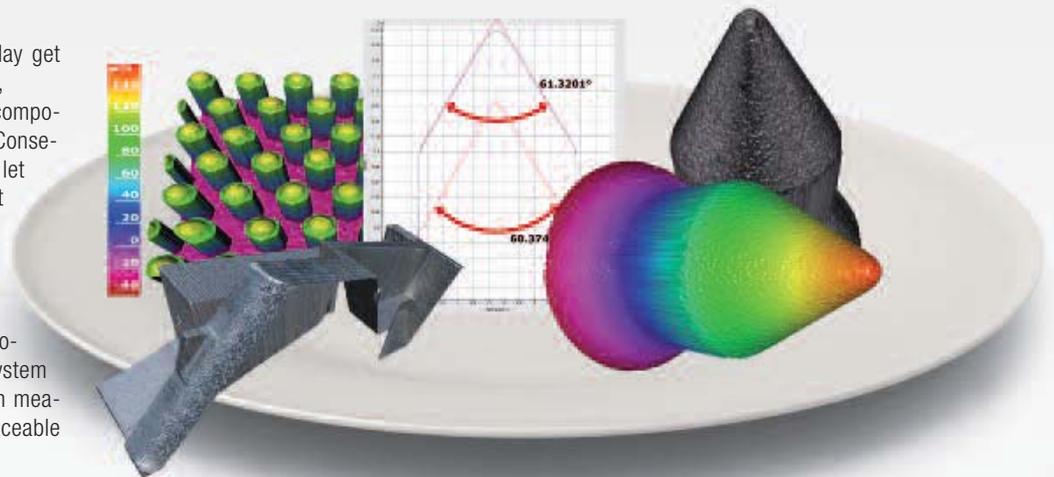
SMALLEST RADII AND ANGLES also across large measurement volumes

"No other optical technology offers a similar high density of measurement. This large amount of measurement points allows me to measure with a vertical resolution of up to 10nm even at large measurement volumes. In practice, however, this means that we can measure even extremely small radii, angles and roughness that were previously not accessible."

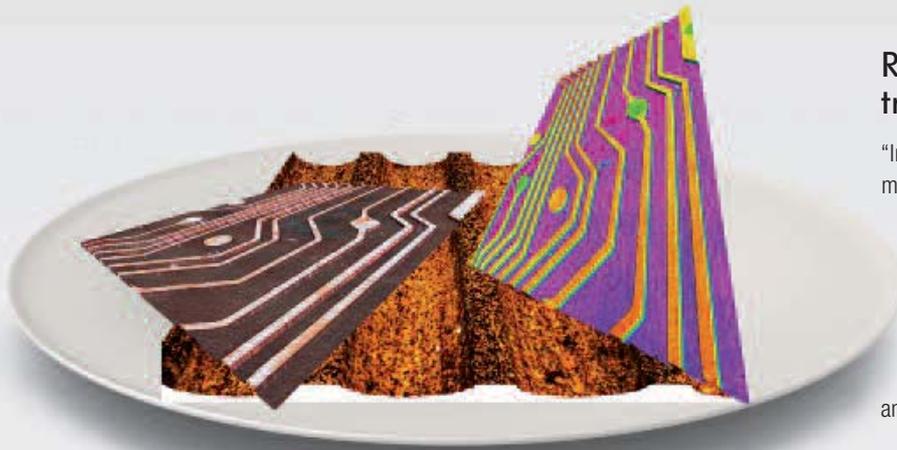


FLANKS with more than 80°

"The products we are producing today get smaller and smaller. At the same time, tolerances have become smaller on components with more complex forms. Consequently, it got rather hard to record, let alone measure the µm-dimensions that we actually manufacture. We have evaluated several optical systems and we always came to the same conclusion: all alternative optical technologies failed in measuring steep slopes. InfiniteFocus was the only system which met its promises. We can even measure flanks steeper than 80° with traceable accuracy."



MEASUREMENT

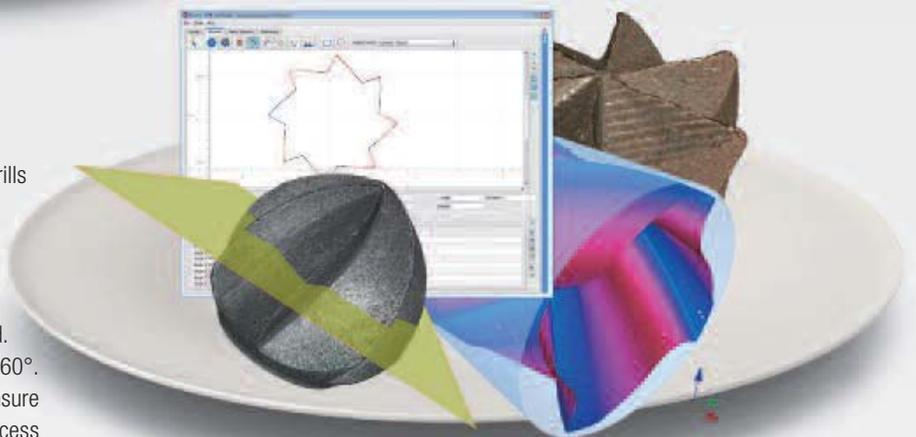


REGISTERED true color information

“InfiniteFocus is the only measurement instrument that measures the topography including data point accurate color information. Due to the optical color image we can easily locate our position on the surface. This essentially simplifies measuring as the measurement range can be identified quickly and we are much more accurate by localizing them. That is how we can identify and measure e.g. corroded areas in a user friendly, practical and precise way.”

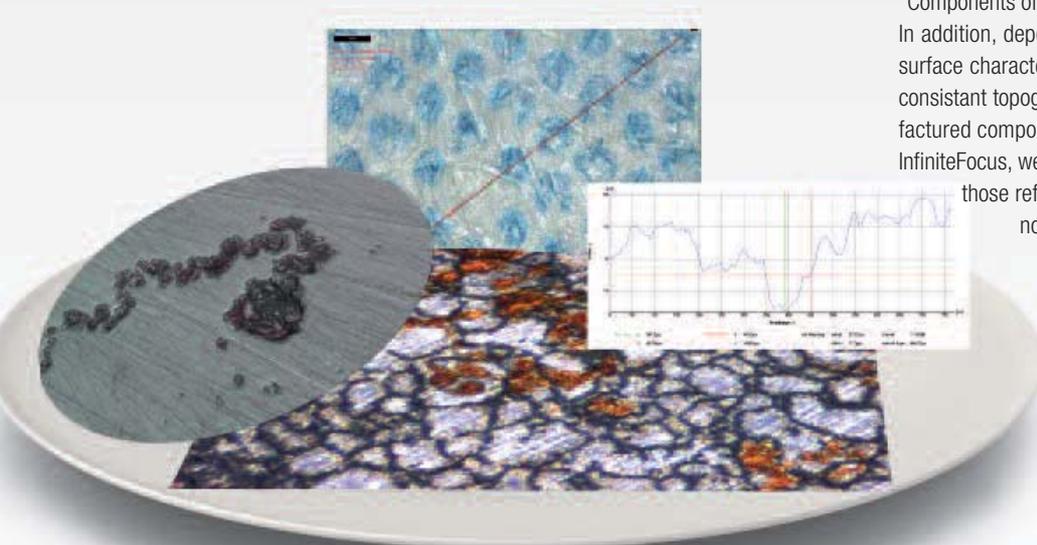
COMPLETE FORM MEASUREMENT by rotating around 360°

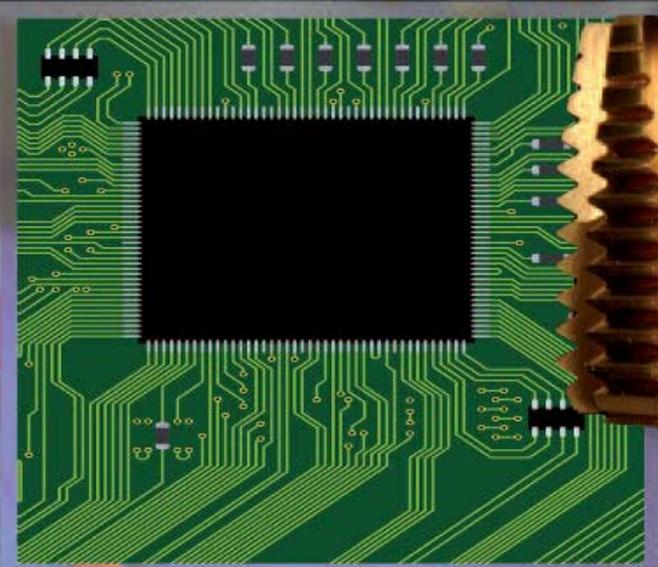
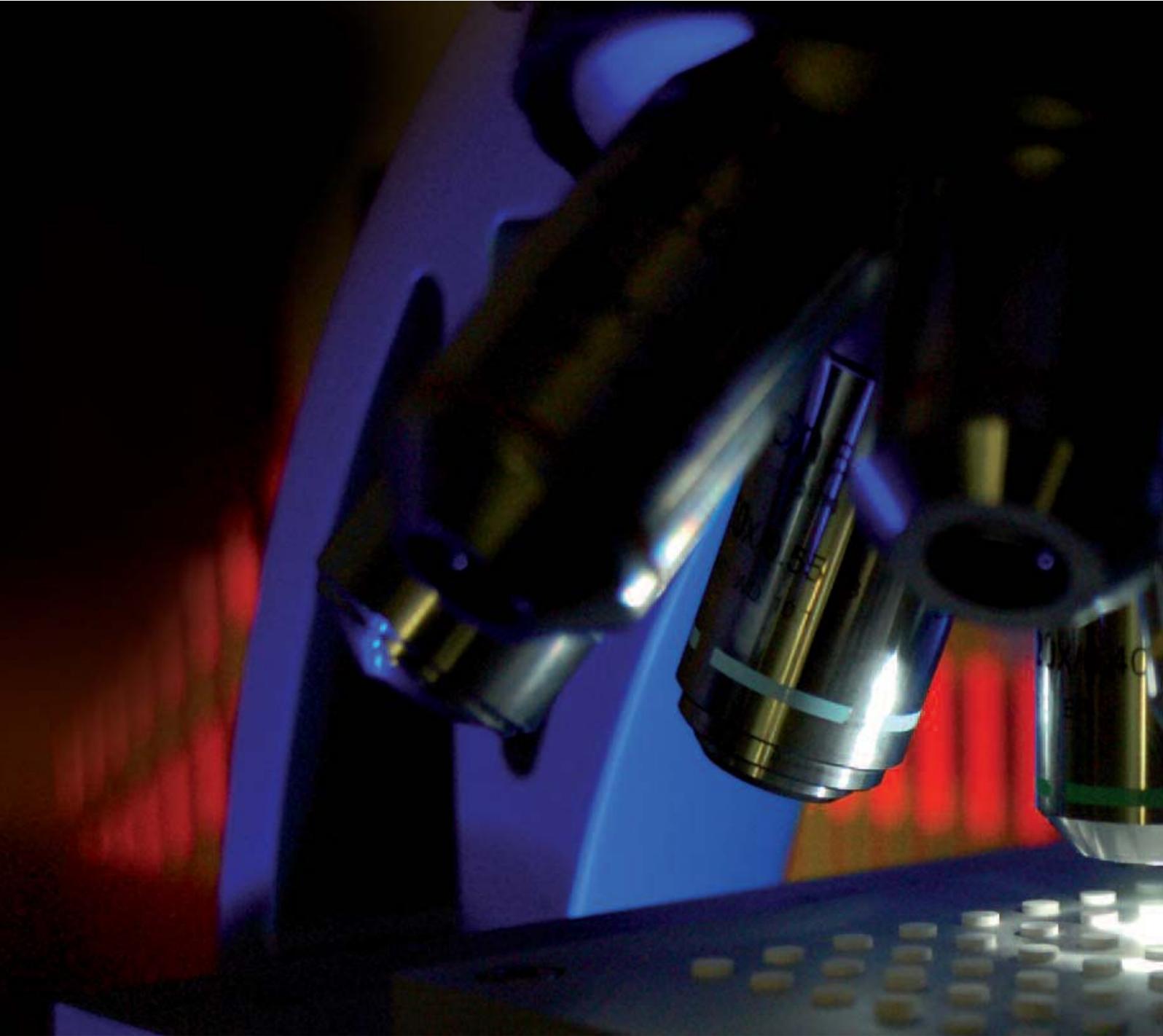
“When manufacturing rotary tools such as micro precision drills about 60 surface parameters influence the durability and the manufacturing result of a tool. For perfect quality assurance full form measurement is essential. This requires that the whole form is captured and measured in 3D. By using the Real3D technology of InfiniteFocus this requirement is achieved. The rotation unit allows me to measure components around 360°. That is how we improve surface finish, check tolerances to ensure dimensional accuracy. This has simultaneously increase process reliability in our production.”



INSPECT SURFACES WITH different surface characteristics

“Components often consist of a combination of different materials. In addition, depending on the manufacturing sector the different surface characteristics need to be measured. We rarely measure constant topographies, it is much more common that the manufactured components have varying reflective properties. By using InfiniteFocus, we have a system which measures independently of those reflections. This is achieved by the SmartFlash technology. It does not matter if the surface is smooth or rough, matt or glossy, reflective or diffuse – the technology makes sure that the software automatically adjusts to the different reflections and therefore exactly to my surface.”





INFINITEFOCUS IN PRACTICE

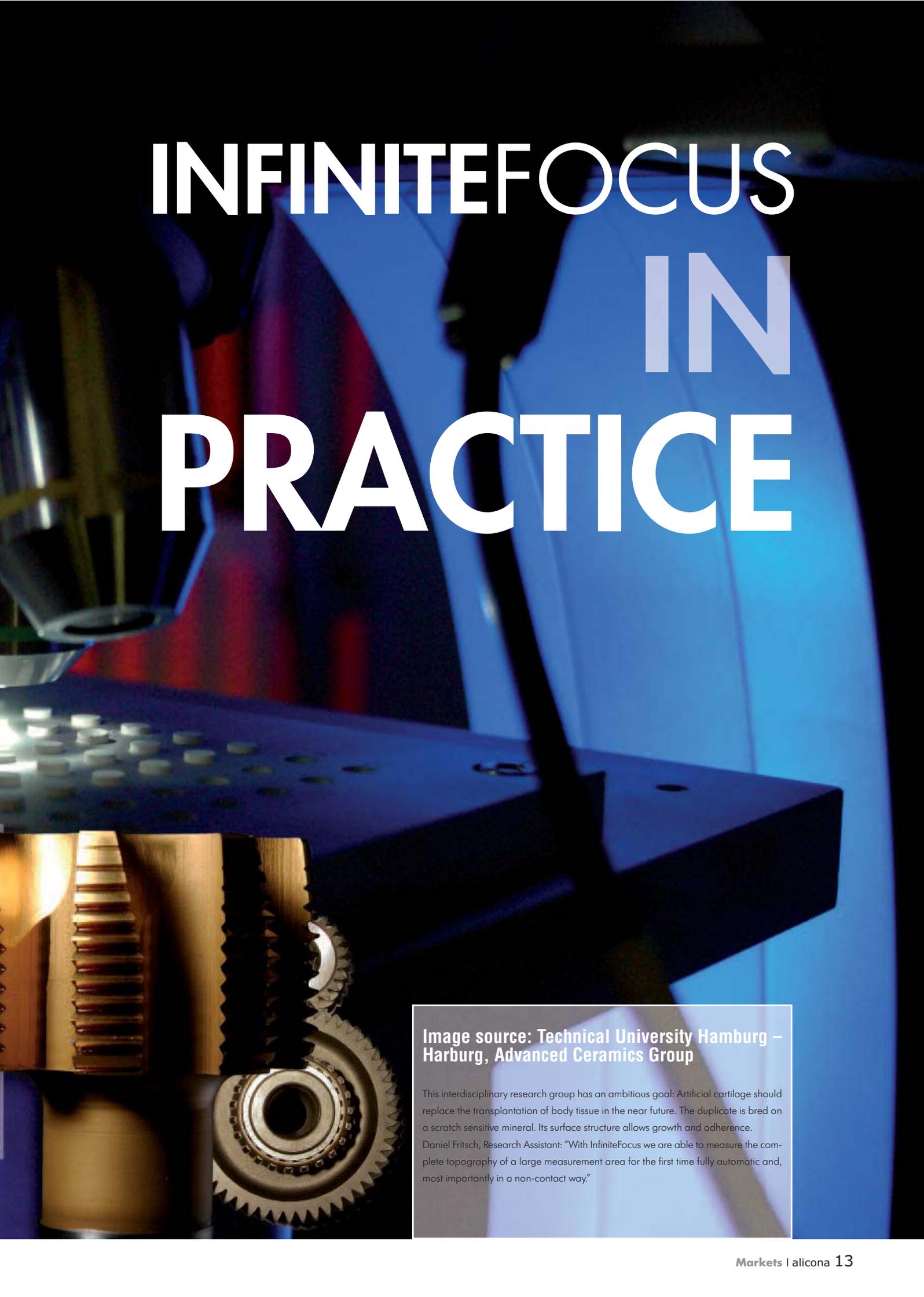


Image source: Technical University Hamburg – Harburg, Advanced Ceramics Group

This interdisciplinary research group has an ambitious goal: Artificial cartilage should replace the transplantation of body tissue in the near future. The duplicate is bred on a scratch sensitive mineral. Its surface structure allows growth and adherence.

Daniel Fritsch, Research Assistant: "With InfiniteFocus we are able to measure the complete topography of a large measurement area for the first time fully automatic and, most importantly in a non-contact way."

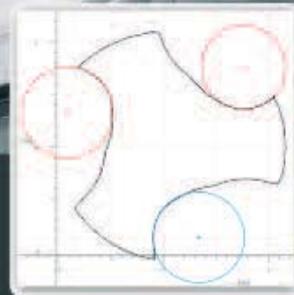
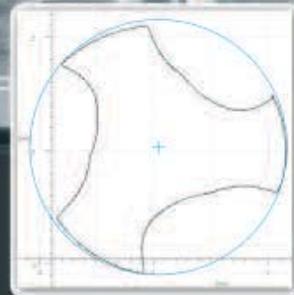
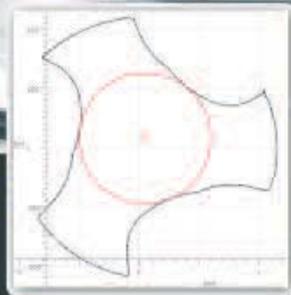
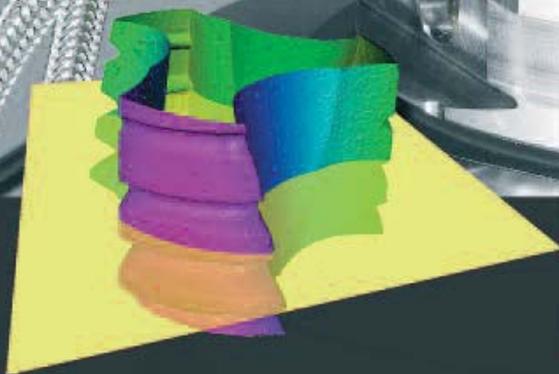
"INFINITEFOCUS IS THE NEWEST AND MOST MODERN MEASUREMENT SYSTEM THAT EXISTS!"

Stefan Jacke,
Team Leader of
Quality Assurance, Fette

MEASURE EFFICIENCY

A 5-axis milling machine is used for investigating materials with low machinability such as oxide ceramics. With InfiniteFocus the resistance to wear, tear and grain quality is measured. Grinding pins are measured before and after the test series.

Image source: ETH Zürich



FORM AND ROUGHNESS IN TOOL INDUSTRY

How formerly immeasurable geometries became measurable

Worldwide leading manufacturers of precision tools such as Bass or Sutton tools share one view. "Since we have known Alicona we measure geometries that were not measurable before." This is true for cutting edge measurement, tool surface measurement in the μm -range and complete form measurement of tap tools. Even across large vertical scanning ranges.

Is my tool conforming to the required geometries? Where are the hidden form deviations to the CAD-dataset located? Does my cutting edge deliver the required machining result? Is my manufacturing result reproducible? What about my process reliability? How long can I use my tool until I have to exchange it due to wear?

The needs and the initial position

As a manufacturer or user – the catalog of requirements in quality assurance is long: Wear measurement, tolerance measurement, reduction of down times, increase of process reliability, improvement of reproducibility etc. The change of manufacturing conditions is an everyday challenge. Tolerances become tighter, whereas cost pressure gets higher and geometries to be manufactured become more complex than ever. Steep flanks, varying reflective properties and small radii are part of the daily business.

It could be assumed that these conditions become an obstacle in quality assurance. Not because production staff fails in manufacturing predefined tolerances in a μm range. This is rather because before InfiniteFocus there was no adequate tool available to measure and consequently prove that tolerances are actually met.

The solution and its advantages

Manufacturers such as Bass or Fette are one step ahead compared to their competitors by using InfiniteFocus. Martin Zeller, Bass CEO, is confident about the most important qualities of the optical 3D micro coordinate measurement machine: "We now measure form as well roughness of our tools. This is an ideal combination which enables us, amongst other benefits, to perform roughness measurement of crucial surface features that have not been accessible before. This now allows us to trace back processes, and, as a result, to take the right measures in order to standardize processes." This is a relevant basis to create reproducibility. "Reproducing one part exactly as the next is getting more and more important for the enforceability of the market", states Zeller about his competitive advantage.

The technical facts and figures

A vertical resolution of up to 10nm even when measuring steep flanks or varying reflective properties make InfiniteFocus a popular measurement instrument. The repeatable measurements of radii as small as $2\mu\text{m}$ and flanks greater than 80° cannot

be achieved by any other optical or tactile technique. The technology of Focus-Variation allows high resolution verification of form, orientation and surface roughness. Not to miss one of the most outstanding features of the system, as Martin Zeller points out: "I don't know any other system that covers as large of a vertical scanning range as InfiniteFocus!"

This enables the user to meet position-, form-, orientation- and diameter tolerances. Normally at least two systems are necessary to reliably and completely measure components. By using InfiniteFocus users are working with only one system to measure roughness as well as form – length, diameter, radius, angle etc.

"This measurement system is an enormous image boost. InfiniteFocus is a high-end system. It's the newest and most modern one that exists."

Stefan Jacke,
Team Leader Quality Assurance,
Fette



FETTE

"One of the most distinctive features of InfiniteFocus is its vertical scanning range. I don't know any other system that offers this large scan height!"

Martin Zeller,
CEO BASS



BASS

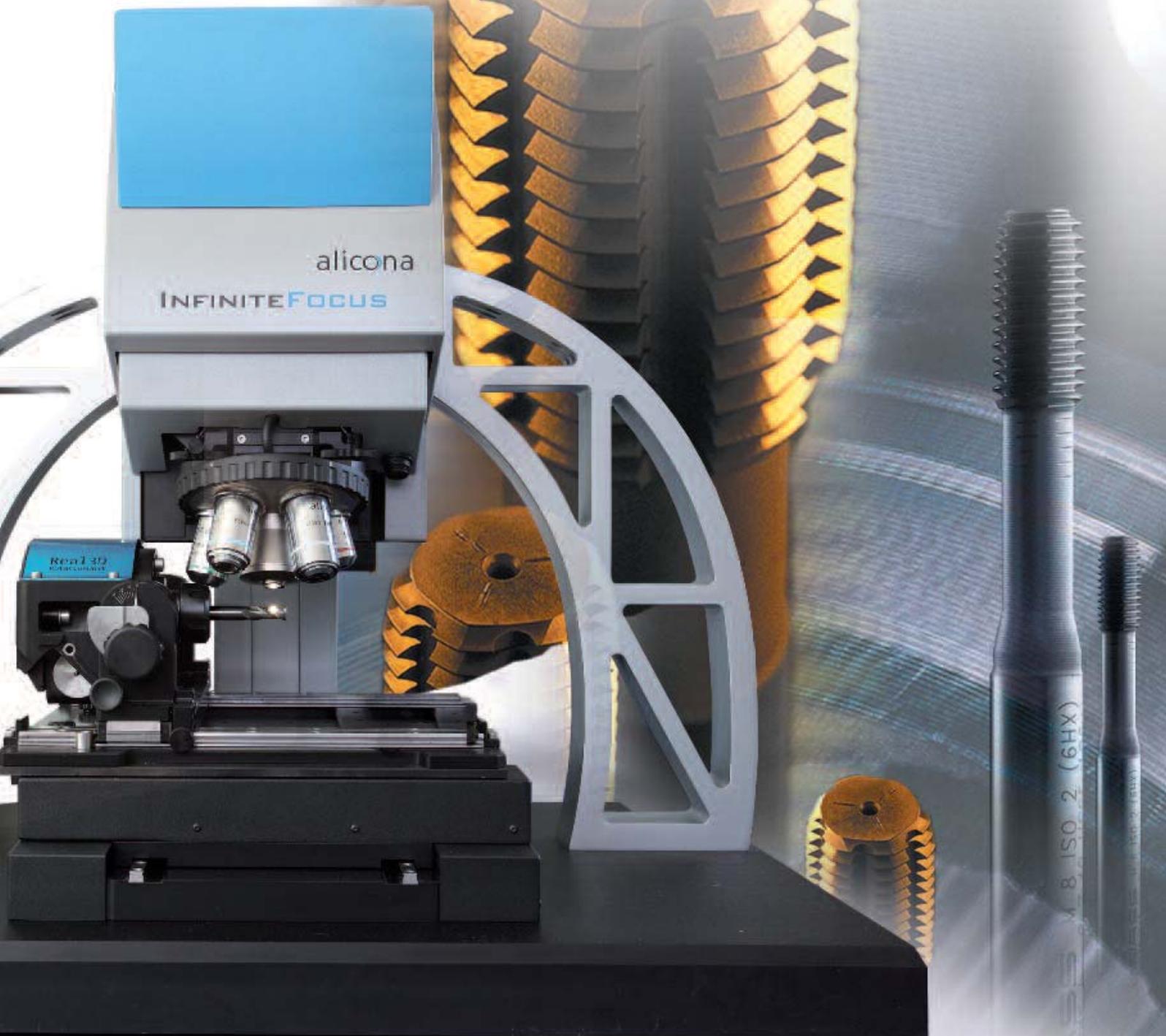


REALITY

MEASUREMENTS OUT OF EVERY PERSPECTIVE USING INFINITEFOCUS REAL3D

As is often said, one of the most significant advantages of optical measurement techniques is the ability to make reality visible.

To see and measure a surface as it really is opens up completely new opportunities. However, up to now the metrological recording of a surface in 3D was restricted to the 2D aspect of topography. InfiniteFocus Real3D now allows the true surface to be viewed and measured from every view point. The Real3D rotation unit, that rotates drills, milling cutters and other rotary symmetric components up to 360° enables the complete form measurement.



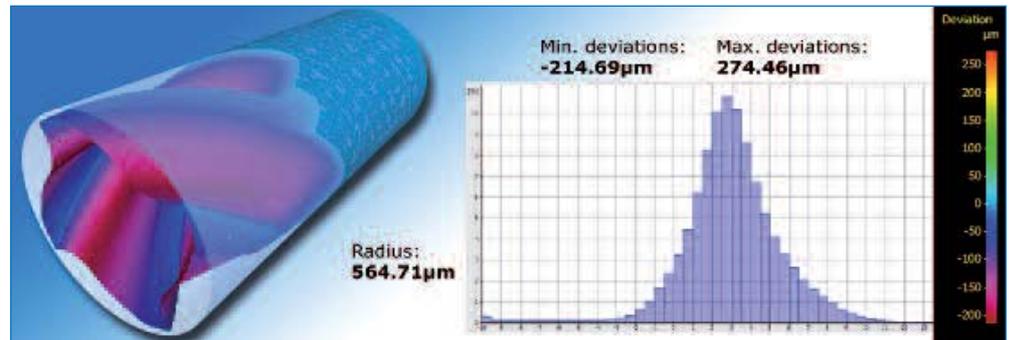
FROM ALL DIRECTIONS

MEASURE COMPLETE FORM AND ROUGHNESS OF TAP TOOLS

Requested by industry and developed by Alicona: full form and contour measurement of drills, milling cutters and other tap tools in 3D with only one measurement. This is how the supplier of optical 3D micro coordinate measurement solutions has catapulted itself into the top of this market segment.

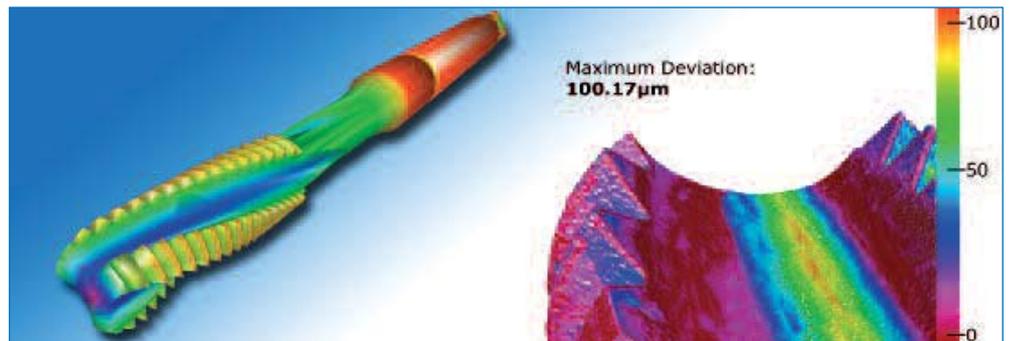
The measurement of tool surfaces from only one perspective is no longer efficient due to the complexity of structures and geometries. As a result, conventional techniques do not allow the measurement of parameters such as relief, undercuts and edge radius. InfiniteFocus Real3D not only fills this gap, the innovative technology also allows the automatic difference measurement of a manufactured component to the corresponding CAD-data. Also, tolerance measurement to ensure dimensional accuracy and reverse engineering is provided.

MEASUREMENT OF FORM, DIFFERENCE AND CONTOUR



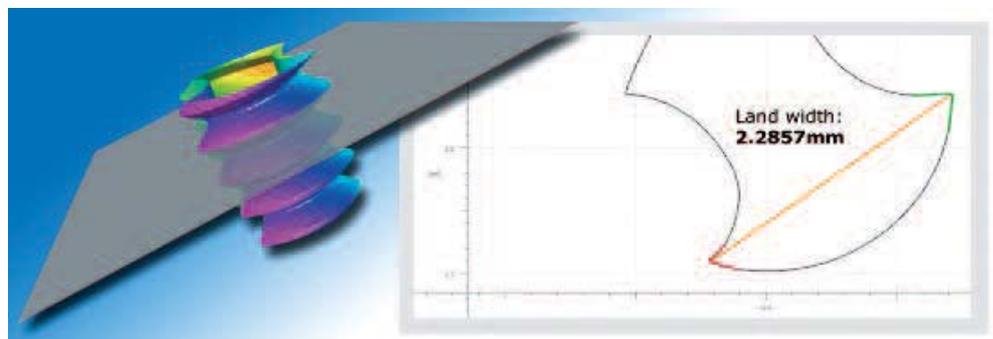
FORM MEASUREMENT...

... is used for measuring regular geometries and curved surfaces. Automatic fitting of spheres, cones and cylinders allow the visualization and form measurement of tools and other components. Also, deviation from target geometry become clear.



DIFFERENCE MEASUREMENT...

... shows wear and deviations to a CAD-dataset. The measurement is simple: the geometry of a tool is measured before and after use, the difference is then automatically measured. It is simple in use and, precise in result.



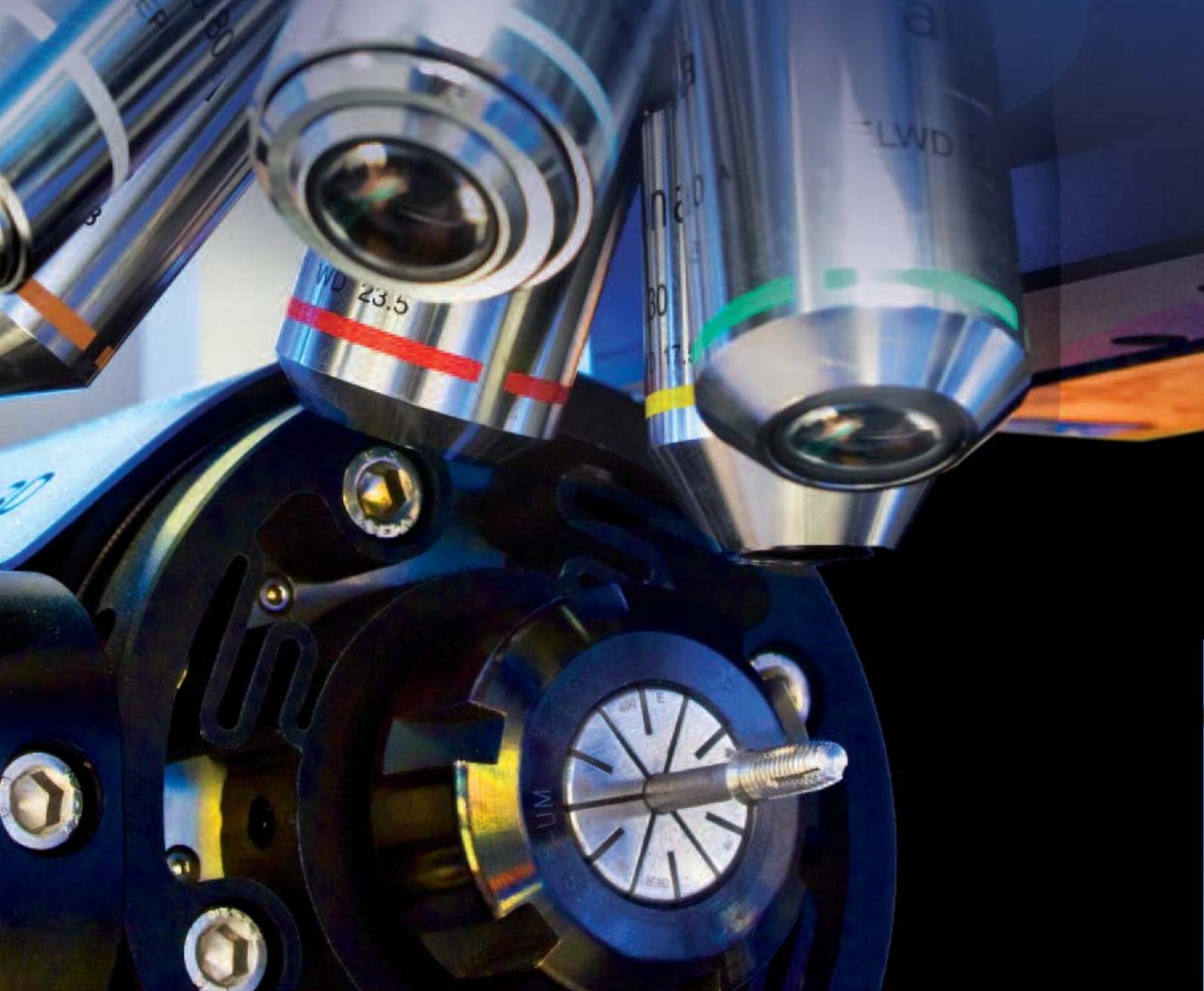
CONTOUR MEASUREMENT...

... allows the measurement of angles, distances, circles, incircles, circumcircles, thread pitch etc. from every perspective and oblique position. Profile contours are measured within a few seconds.

A SELECTION OF MEASURABLE PARAMETERS WITH INFINITEFOCUS REAL3D

- » Surface roughness
- » Rounded edge
- » Flank angle
- » Major diameter
- » Relief
- » Chip angle

ROUGHNESS MEASUREMENT MATTERS FOR DENTAL IMPLANTS



This is because the surface roughness dictates how permanently an implant mates together with the jaw bone. With the optical 3D measurement system InfiniteFocus the roughness can be measured wherever it is required, including the root of the thread of the implants.

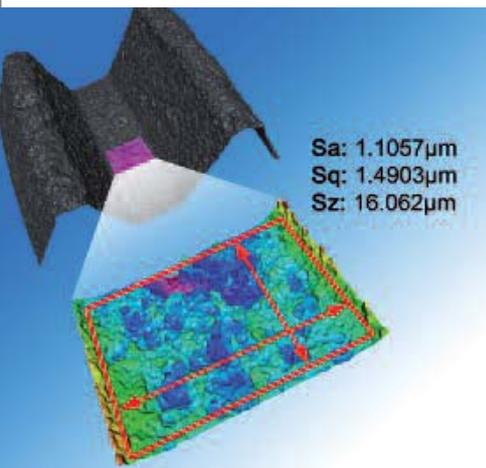
The quick adhesion with the jaw bone is dependent on the protein binding capacity of the implant.

The surface characteristics of a dental implant are crucial as it is the decisive factor for the successful, and permanent, adhesion with the jaw bone. In order to grow together quickly and sustainably, the surface of the implant has to have the necessary characteristics to allow protein binding. Optical 3D measurement with InfiniteFocus provides the numerical verification of this and consequently the verification as to whether the implant has the required surface quality for a successful treatment.

Due to the large measurement area this measurement can only be meaningful if areal, and not line based measurements are used. As a supplier of areal based 3D measurement across large areas Alicona is an innovative pioneer in this field.

Measure roughness at the root of the thread and steep flanks

"Everything that is in contact with the bone needs to be measured. And it is really important that I can also measure the roughness on the root of the thread," states Dr. Frank Rupp. Rupp is the head of the department Prosthodontics (which is a section of Medical Materials & Technology, directed by Prof. J. Geis-Geistorfer at the University Hospital Tübingen, Germany) and an expert in the field of surface modifications of implants.



Roughness measurement on a tooth implant
Areal roughness measurement on the root of the thread of a tooth implant measured with the optical measurement device InfiniteFocus

He has focused his investigations primarily on the condition of the surface of the implant in order to ensure the best possible bone integration. InfiniteFocus is for him the system

that produces the best results of are based roughness measurements. "We do not know about any other system that delivers as sound statements across such large measurement volumes," states Rupp. Results already conform to ISO 25178 and provide not only linear but also area based measurements. The user not only acquires more information about the surface but also has the advantage of higher repeatability and traceability.

"3D measurement of the surface performed with InfiniteFocus allows us to define the correlation between the topography of the implant and its performance in the body providing more substantiated results, with numeric values. This enables us to draw conclusions about the biological behaviour; and with this we can optimize new materials," Rupp continues. This optimization also includes the inspection of the correlation between implant topography and the wetting behaviour. The aim is the development of implants assuring that the topography positively effects the distribution of red blood cells within only a few minutes.

Larger surfaces measured faster

In comparison to other traditional technologies the results from the optical measurement system are not only more significant but also more accurate, faster and therefore more cost efficient. Frank Rupp knows this from his everyday work: "Measurements with a scanning electron microscope are time consuming and complex due to the complex sample preparation. Using a tactile system one is restricted by the deflection of the stylus tip. For thread implants where I also need to measure on the root of the thread this technology is not useful at this point."

All parameters in a single measurement

Measuring cost efficiently is also significant as several relevant parameters can be measured with one system. As a measurement system that combines all functionalities of a roughness- and form measurement device InfiniteFocus also offers the functionalities of an optical profilometer and a micro coordinate measurement machine. With only one measurement system the complete range of classical surface metrology (roughness measurement) and coordinate measurement technique (for form measurement) is covered. Even on complex forms with various surface characteristics a resolution of up to 10nm can be achieved on large vertical and lateral scan ranges.



"We do not know about any other system that delivers as sound statements also across large measurement volumes."

Dr. Frank Rupp
Prosthodontics at
University Hospital
Tübingen

360° measurement for full form measurement

Meaningful surface characterization requires the full form measurement of the whole implant. This is achieved by the optional rotation unit which provides a 4th axis to allow 360° measurement. This is how the InfiniteFocus Real3D technology allows the manufacturers to measure the thread pitch and therefore prove the dimensional accuracy. Also form deviations to a reference object are measured automatically. This is achieved by difference measurement between a component and CAD-dataset determining the variances to the nominal.



3D denture molding

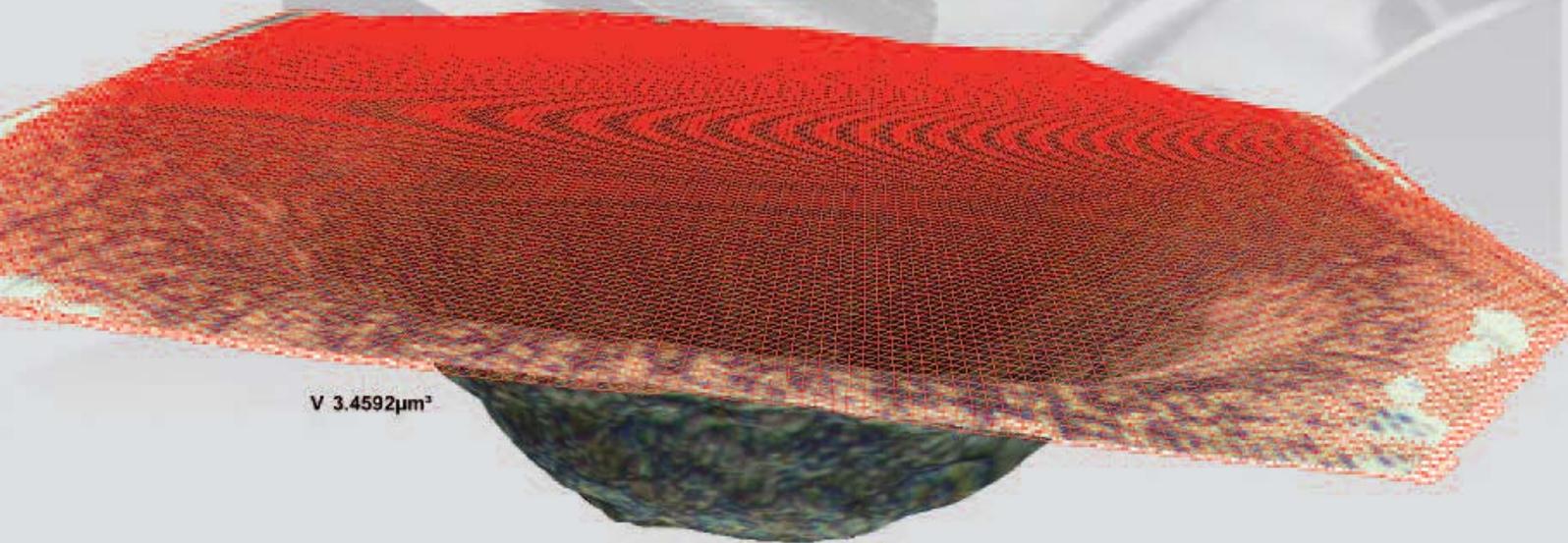
InfiniteFocus also achieves significant results across large measurement areas, and volumes, in high resolution and with a high measurement point density

360° measurement of a tooth implant
By using the Real3D technology implants are measured around 360°

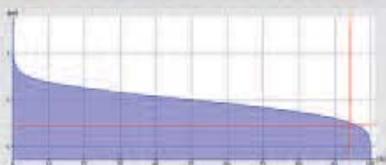
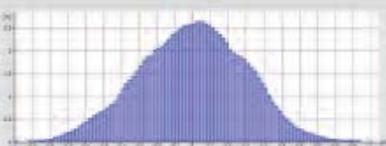
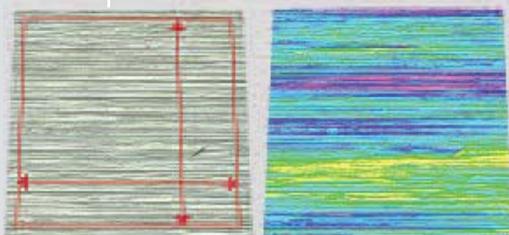
CAUSE AND EFFECT

“InfiniteFocus closes the gap between classical 3D-coordinate measurement techniques and roughness measurement.”

Richard Bäuml, Gear Research Centre (FZG) at the Technische Universität München, Germany.



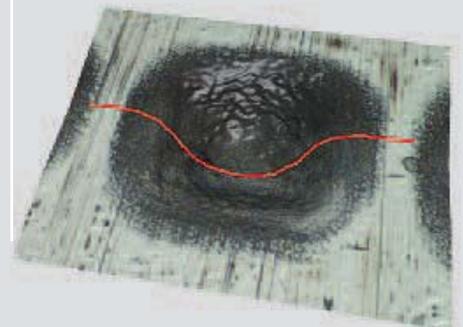
Area based roughness measurement of tooth flanks.
Compared to tactile measurement, the FZG not only benefits from more robust results but also by an improved characterization of the surface properties. The large lateral and vertical measurement range allows the 3D visualization of a whole tooth. This enables the research centre to perform a setactual comparison of flank modifications.



Examination of gear flank failures on the example pittings and micro pittings.
Pittings and micro pittings are classic material fatigue damages on the tooth flanks. With InfiniteFocus the damaged area of the tooth flank can be quantified. Unlike tactile measurement the area close to the root of the tooth is by now accessible without destruction.



InfiniteFocus in fundamental tribological research: Volume measurement of micro structured polished discs.
The lubricant gathers in the lasered structures and is carried through the elasto-hydrodynamic contact. The improved lubrication can reduce the friction in the contact. With InfiniteFocus geometries and volumes of such micro structures can be measured to determine the influencing parameters and to secure process reliability of new manufacturing processes. Complex reflection properties are no challenge: “With the X-SmartFlash technology even inhomogeneous surfaces with varying reflection properties can be measured repeatable and in high resolution,” Richard Bäuml.



INFINITEFOCUS IN MATERIAL SCIENCE

The load-carrying capacity of gear drives is affected by the used material, the micro geometry on the material surface, the topography of the tooth flanks, and its lubrication.

For these reasons the Gear Research Centre (FZG, Technische Universität München, Germany) has chosen the InfiniteFocus as it can measure form and roughness on former inaccessible areas. Richard Bäumlér, research assistant at FZG says: "We are now able to measure areas that are not accessible by common tactile measurements devices. A roughness measurement, for instance, only makes sense if the measurement can be performed orthogonal to the grinding direction. Because this grinding direction is normally in the direction of the face width, the gear has to be cut in sections for a measurement with a tactile stylus tip. Now we quantify the roughness and the grinding marks in high resolution and in a non-destructive way." In contrast to common tactile roughness measurements, InfiniteFocus also measures large components 3-dimensionally. "We not only benefit from more robust results, but also by a better characterization of the surface. The large lateral and vertical scan areas allow us the measurement of a complete tooth flank," says Bäumlér. "This, for example, opens up the opportunity to perform desat-actual comparisons of tooth modifications. InfiniteFocus therefore closes the gap between the classical 3D coordinate measurement and roughness measurement techniques."

INFINITEFOCUS APPLICATIONS IN AUTOMOTIVE INDUSTRY

In addition to surface measurement and failure analyses of gears, the 3D measurement device is also used for the examination of automotive components.

Typical applications are the measurement of multiple disk clutches or synchronizers as they are used for example in motor vehicle gears. The operational behaviour is influenced by the friction pairing and the friction surface grooves. For this reason the measurement of surface structures and the characterization of friction surfaces with appropriate area based parameters are important. "In order to optimize function and durability of the various elements, we have

to know the friction behavior and to what extent it is influenced by the topographic parameters," explains Richard Bäumlér.

The Gear Research Centre (FZG) is part of the Institute for Machine Elements at the Technische Universität München. The focus of research activities are drive systems and components. In accordance with the specific purposes of the research project, the whole object (transmission) or one element out of it (e.g. gear wheel, bearing) are investigated. Since the beginning of 2010 the high resolution optical 3D surface metrology system InfiniteFocus is frequently used and is also available for service cooperation.

Contact: Professor Dr.- Ing. Bernd-Robert Höhn, fzg@fzg.mw.tum.de, www.fzg.mw.tum.de

INFINITEFOCUS AT A GLANCE:

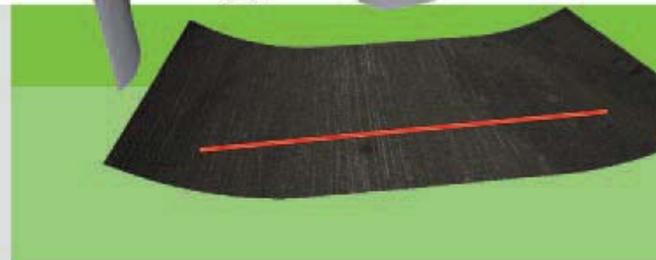
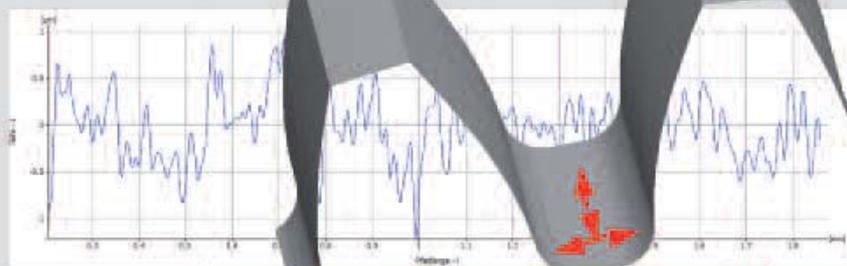
"IN CONTRAST TO TRADITIONAL TECHNIQUES
INFINITEFOCUS OFFERS THE FOLLOWING ADVANTAGES:

- » Form and roughness are measured across large lateral and vertical scan ranges in only a single measurement
- » Characteristic surface parameters are measured on areas that cannot be accessed by tactile systems (e.g. roughness measurement orthogonal to the grinding direction of the tooth root)
- » InfiniteFocus offers the opportunity of a set-actual comparison (e.g. flank modifications of gears)
- » "Soft" surfaces and materials also used for gears such as polymers and bronzes as well as sintered or organic friction linings of disk clutches and synchronizers can be measured without influencing/damaging of the specimen
- » InfiniteFocus measures highly structured surfaces and materials with complex reflection properties."

Richard Bäumlér, FZG

Determination of roughness and topography at the tooth root.

The tooth root load-carrying capacity is also influenced by the surface characteristics in this area. Grinding grooves in the intersection between tooth flank and root of the tooth may reduce the tooth root load-carrying capacity which can result in tooth breakage. With InfiniteFocus roughness and grinding grooves are quantified in a non destructive way.



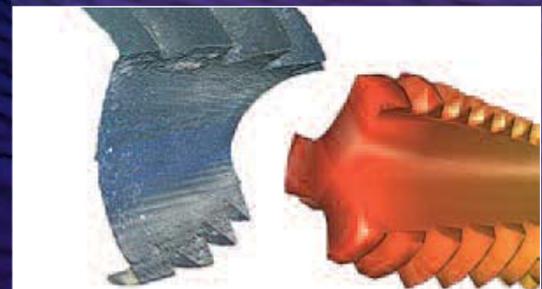
INFINITEFOCUS AND

LARGE ACHIEVEMENTS ON SMALL COMPONENTS.



"I don't know any other system that delivers at this time results at it is achieved with InfiniteFocus. We receive a vertical resolution of up to 10nm even across large measurement volumes. This means that we are now able to measure even very small radii and angles which we have not been able to measure before."

Mark Raleigh, EDM



Automatic comparison measurement
to a CAD dataset

MICRO COMPONENTS:

What does a cell phone, a subnotebook, a nearly invisible hearing aid and a medical device have in common?

Their miniaturization.

Complex components such as gears or whole micro pumps are now commonly manufactured in the μm range using milling, eroding or injection molding. The challenge is to measure these “intelligent miniatures” in order to verify the quality. But that is not enough – it is also necessary to have effective and traceable 3D surface measurement and characteristics that document the quality of the surface simultaneously with its form.

The smaller geometric forms of micro structured components become, the higher is the challenge in meeting and measuring the required tolerances of bores, gates, grooves and other forms. Also, tribology studies on friction surfaces with high precision geometries have become increasingly important.

Exceptional surface quality with a dimensionally accurate geometry are the basis for low wear of e.g. micro bearings or micro gears.

The repeatable and high resolution measurement of micro manufactured components has become increasingly important in quality assurance.

It is mainly the surface of different materials that is a challenge for optical measurement devices: In practice the most common topographies are of high-tensile components such as carbide, carbon, ceramics and hardened steel. These materials often show varying reflective properties combined with complex forms and steep flanks. By using InfiniteFocus, manufacturers have a system that measures inde-

pendently of those reflections. The software automatically adjusts to the different surface conditions and delivers repeatable measurement results.

**When small parts become wide eyed:
Created for the world of miniaturization**

InfiniteFocus enables the radius and angle measurement of flanks exceeding 80° : This is a function which is especially important for the measurement of, e.g., gears and threads.

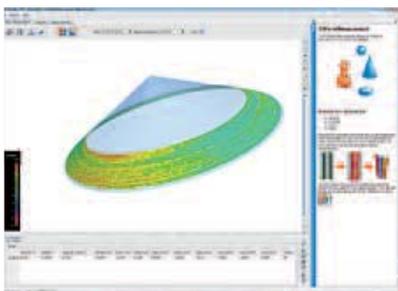
At the same time the high measurement point density ensures high repeatability even with challenging measurement conditions. This repeatability is very important if the 3D measurement data is used to boost process reliability.

The InfiniteFocus high tech measurement technique has great qualities so that the products in the field microsystem technologies do not just become smaller, but also better, and produced in a more economic way: InfiniteFocus provides nearly endless opportunities in this field.

TYPICAL APPLICATIONS WITH THE OPTICAL 3D MICRO COORDINATE MEASUREMENT MACHINE

INFINITEFOCUS ARE:

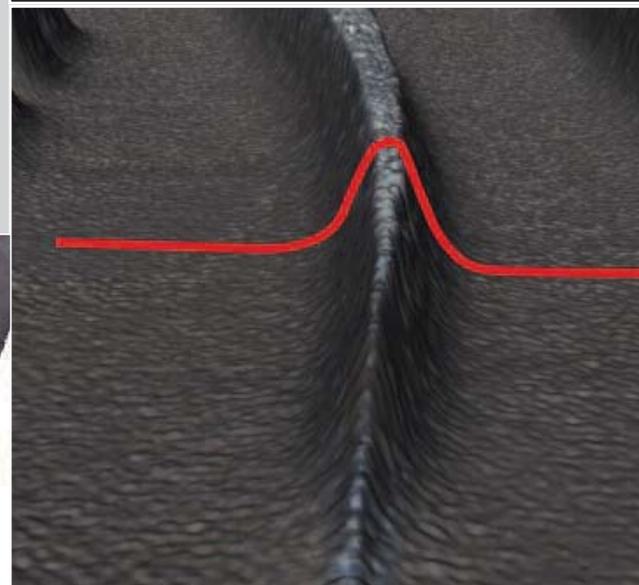
- » MIM (Metal Injection Molding) & CIM (Ceramic Injection Molding)
- » 3D measurement of micro structured surfaces and quality assurance of micro milling processes
- » Quality assurance of micro injection molding of metal and polymer



Form measurement
to check dimensional accuracy

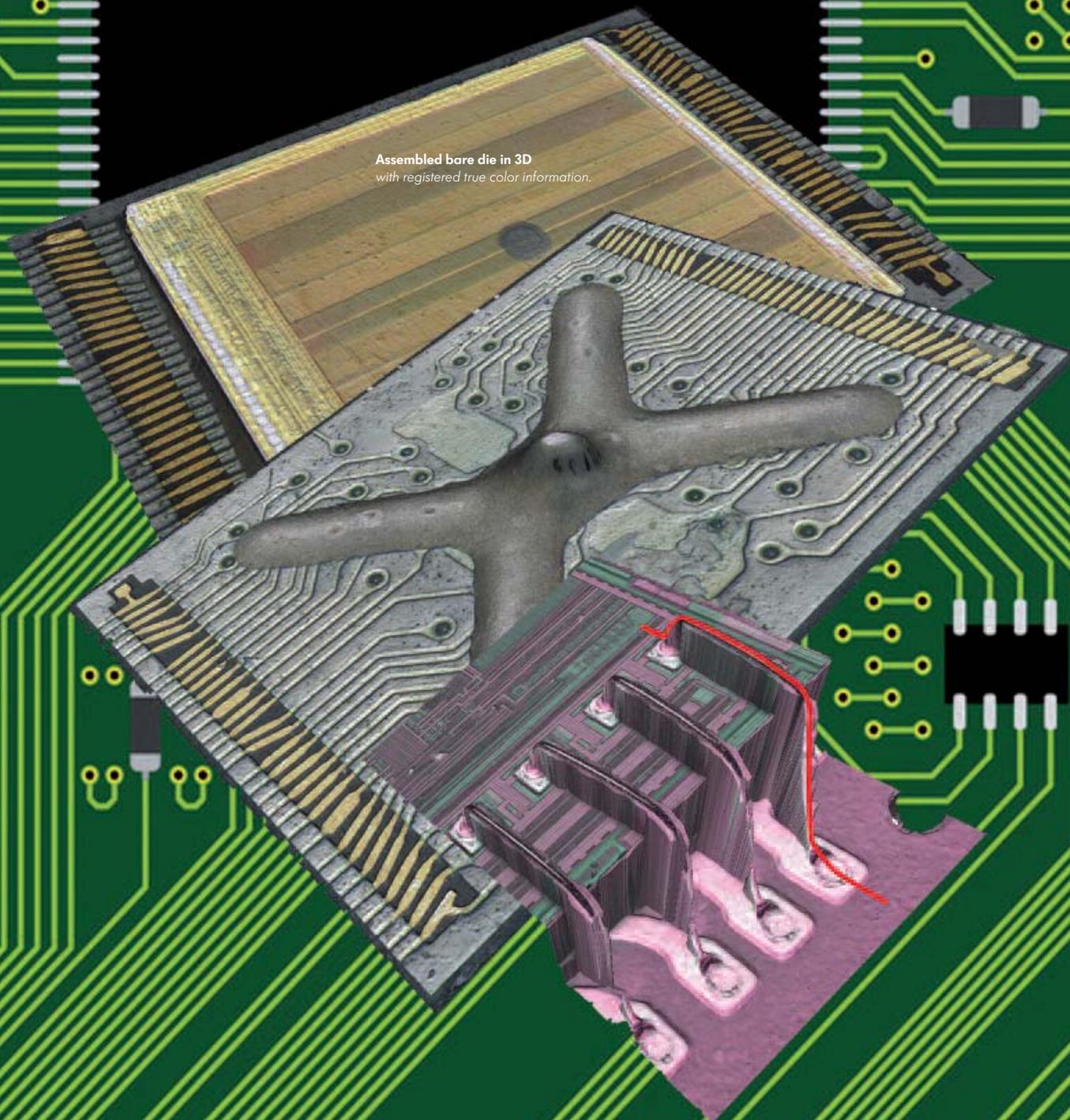


Difference measurement
to reference geometry



WITH **INFINITE**FOCUS FROM THE FIRST TO THE LAST **PRODUCTION STEP**

Assembled bare die in 3D
with registered true color information.



MICRO ELECTRONICS:

The progressive miniaturization and demand for cost reduction are the driving forces behind micro electronics. These days, “uncased components” or, so called bare dies are directly assembled from the wafer via bonder on substrates or lead frames. The contact is implemented by wire bonds. The non-destructive evaluation of these sensitive connection areas is only one out of many advantages that is gained with InfiniteFocus.

During the various manufacturing processes the InfiniteFocus 3D measurement system enables the high precision, non-contact and non-destructive measurement of...

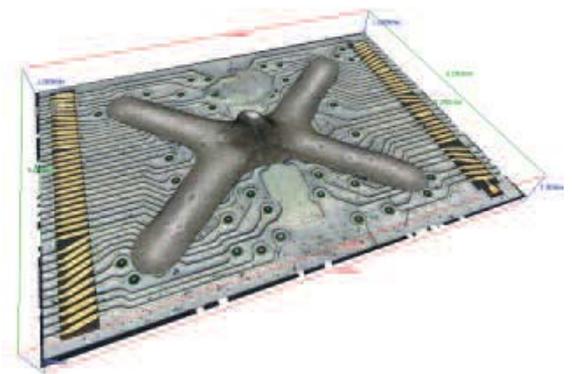
- » dispensing of the glue with its three dimensional extension (volume), position and form
- » lateral position of the assembled bare dies in x- and z-direction
- » twisting angle of the bare die
- » tilt of the bare die compared to the substrate or lead frame
- » distance of the bare die compared to the substrate or lead frame
- » form and orientation of the wire bond loops (typical gold wire diameter 20 – 30µm)
- » micro characteristic and geometry of wedge bond (substrate side) and nail head (die)

The common and traditional share and pull tests for wire bonders are reduced to a minimum, or even left out completely, since they are always destructive.

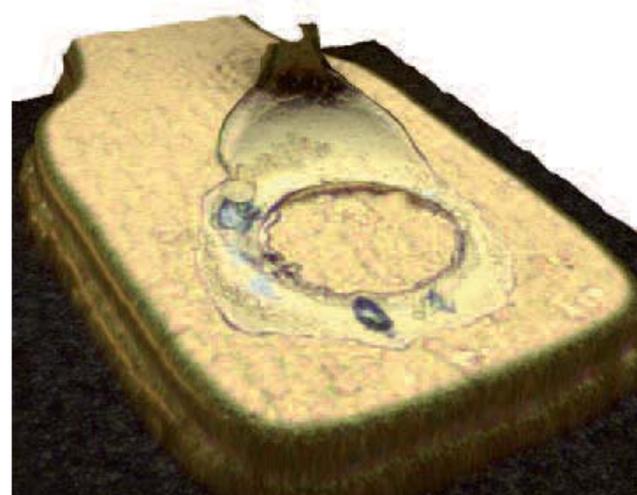
The 3D geometry in addition as well as the surface characteristic (e.g. roughness of the contact pad) of the substrates and lead frames that are assembled can be measured.

Several process parameters such as the dispensing of glue, the assembling and the wire bonding can be defined for the prototype production.

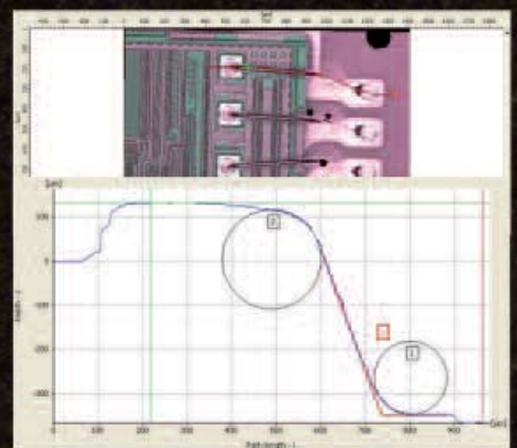
InfiniteFocus is also used in production for the measurement on random bases. The advantages for the electronic manufacturer are reliable and well documented quality, security and reputation. But most of all he benefits from reduced manufacturing costs and a stable manufacturing process.



3D surface dataset of a glue cross
With InfiniteFocus volume, position and form are measured.

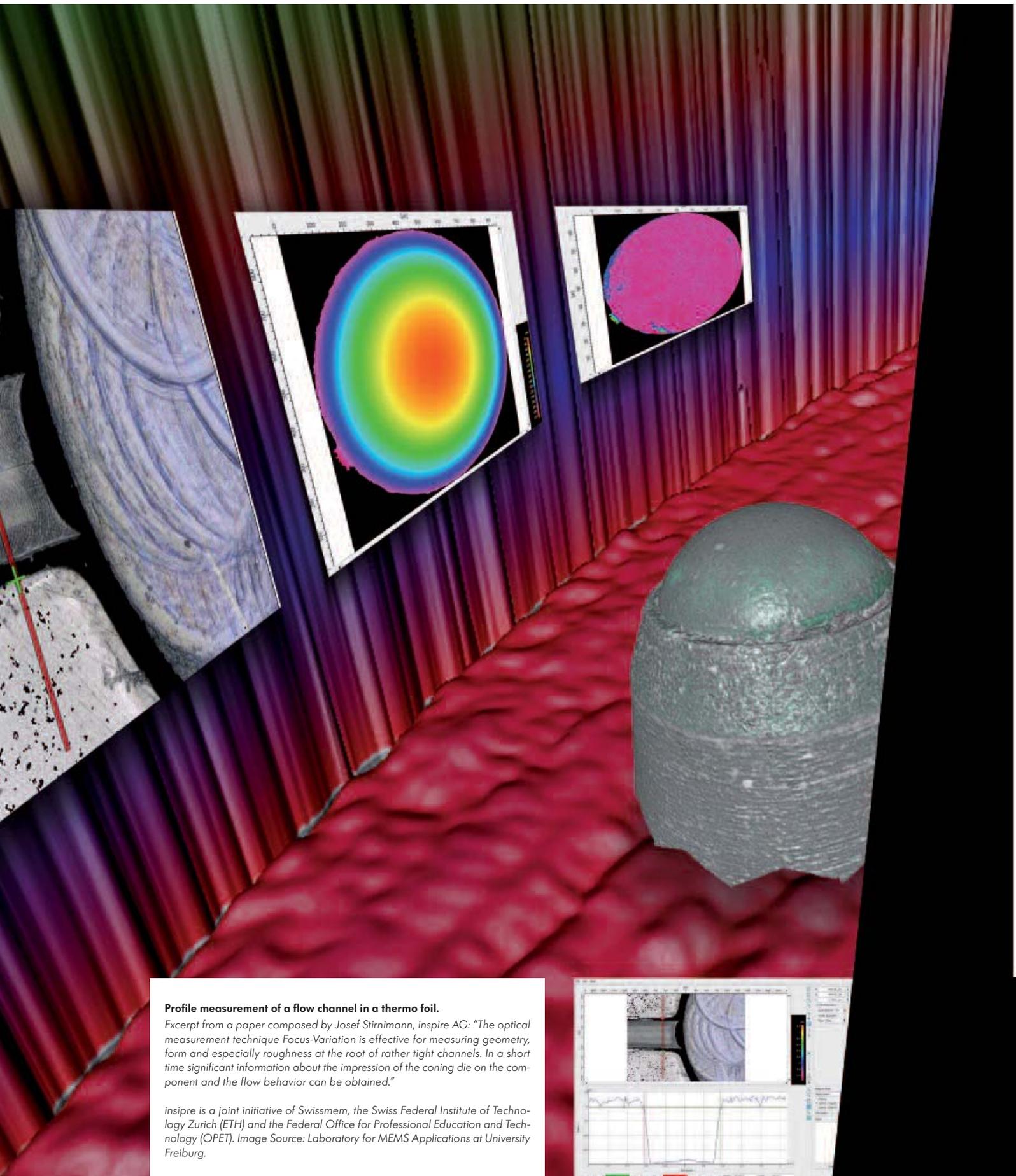


Micro characteristics of wedge bond on substrate.
InfiniteFocus measures non-destructive and the complete geometrical characteristic: depth, cross section, radii, angle...
This is how the stability of the connection is numerically verified.



3D form measurements of wire bonds.
Also, the maximum height is measured.

ART IS VERSATILE.



Profile measurement of a flow channel in a thermo foil.

Excerpt from a paper composed by Josef Stirnimann, inspire AG: "The optical measurement technique Focus-Variation is effective for measuring geometry, form and especially roughness at the root of rather tight channels. In a short time significant information about the impression of the coning die on the component and the flow behavior can be obtained."

inspire is a joint initiative of Swissmem, the Swiss Federal Institute of Technology Zurich (ETH) and the Federal Office for Professional Education and Technology (OPET). Image Source: Laboratory for MEMS Applications at University Freiburg.

POLYMER IS AS WELL.

InfiniteFocus measures the surface structure, determines the roughness, checks the dimensional accuracy and automatically compares the measured geometry with reference geometry. Strain analysis, material characterization and the examination of ageing are daily requirements. The focus lies on the quality assurance, and difference, of the injection mold and the manufactured injection molded component.

InfiniteFocus is a well established system to determine which regions of the cooled injection molded component are different to the target geometry of the injection mold. Numerical data of shrinkage are provided automatically and in a high resolution, even at steep flanks and smooth reflective surfaces. Also, variance analysis between the molded component and its accordant CAD dataset is performed. InfiniteFocus registers the two datasets, calculates a 3D difference model and displays the difference as a 3D colored dataset. Variances can then be seen in color and numeric data are provided throughout statistics. By checking the dimensional accuracy also surface defects such as sink marks can be easily verified.

Measure form and roughness with only one system: The strategy for success in (polymer) industry

Form and roughness measurement are relevant for defining the optical properties of solid objects. The roughness measurement ensures that e.g. a grained surface will give a homogeneous view with consistent gloss value. The gloss that overlays the roughness is measured using the surface texture measurement and the form subtraction. This can only be achieved by an area based measurement technique as linear

techniques measure only one profile and therefore do not provide the density of measurement points required for such measurements. In contrast, InfiniteFocus measures area based across large measurement fields with a high density of measurement points. This makes the instrument ideal for quality assurance.

Micro die-casting: geometry, surfaces and the dimensional accuracy of components demand an optical 3D measurement technique

Polymer components, as in other industries, are becoming smaller. The form is becoming increasingly complex due to the extremely small radii and nearly vertical slopes of e.g. molded components. Also, surface reflections are rather complex due to variation in material properties. These factors challenge measurement techniques for quality assurance.

The InfiniteFocus, as a surface and form

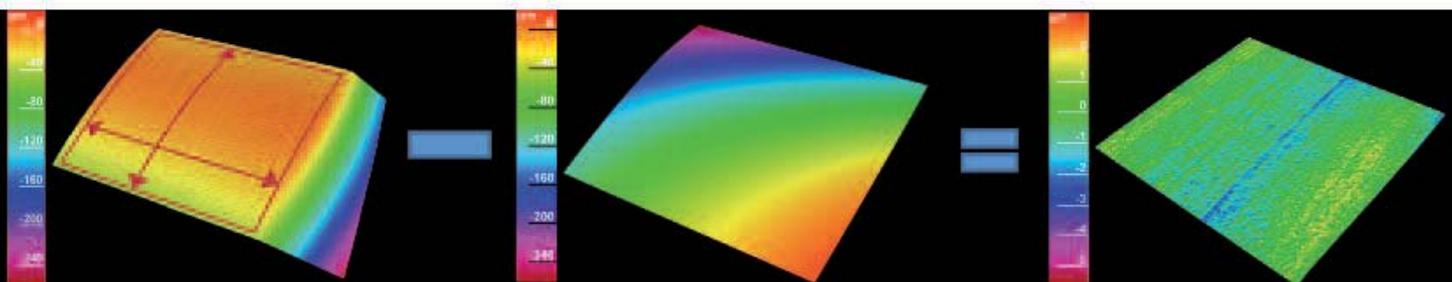
measurement device, is able to meet these challenges providing the information required in this field.

Micro systems, now used in medicine, telecommunications, electronics, fluidics, sensor technology and many others require detailed surface structure measurement, also known as roughness, in addition to the measurement of form.

"In many instances the functionality of a component can be defined or predicted by using a roughness measurement. It can, for example, show how a component reflects light, how fluid flows over a material or how two bearing surfaces move or interact. The roughness measurement enables the design engineer to specifically manufacture a component that complies with the desired function to a great extent."

Professor Richard Leach, *Principle Research Scientist, NPL*

Whereas the dimensional accuracy is assured by the form measurement, the roughness measurement is relevant for the functionality of the whole component. Prof. Richard Leach, Principal Research Scientist from the National Physical Laboratory (NPL), comments about the significance of roughness measurements: "In many cases the function of a component can be defined or predicted. It can for example be inspected how a component reflects light, how fluid material reacts or how two bearing surfaces move or interact." The Focus-Variation technology is effectively used wherever micro structures need to be measured even in the nanometer range.



Sometimes, form has to "disappear" in order to measure the surface roughness. This is achieved by the InfiniteFocus measurement module "Form Removal".

SECURING OF EVIDENCE REQUIRES

MEASURE - DON'T SNIFFLE AROUND!

INFINITEFOCUS



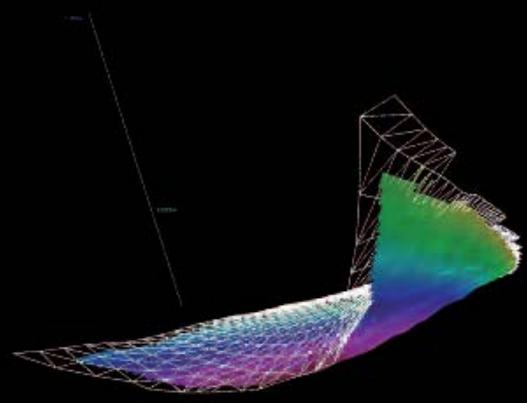
Human bone in 3D



Detail of knife-holder



Firing pin in 3D
with registered color information



Volume measurement
of a knife holder

INFINITEFOCUS

The Netherlands Forensic Institute is under the jurisdiction of the Dutch Department of Justice and has about 40 areas of expertise. InfiniteFocus is used for many types of cases that are investigated for the police, lawyers, the ministry of armed forces etc.

Some typical fields of forensic expertise are Pathology, Anthropology, Toxicology, Chemistry, Ballistics, Fibers, Documents, Handwriting, Narcotics, Explosives, DNA, Marks etc.

**RENÉ PIETERMAN,
FORENSIC SCIENTIST AND
SPECIALIST ON INVASIVE
TRAUMAS, GIVES AN
INSIGHT INTO HOW
3D SURFACE METROLOGY
CONTRIBUTES TO CRIME
DETECTION.**

Why is 3D surface measurement necessary for crime detection? Why is InfiniteFocus the appropriate tool for you?

Modern forensics cannot work without 3D surface analysis. Our department has to examine all kind of features related to tools, objects, weapons etc. We also deal with marks on victims' bodies. InfiniteFocus was purchased for a specific reason. We were looking for a system for the examination and comparison of tissue, bones etc. of human corpses with tools, objects, weapons etc. Particularly, the system is used to measure tissue and bone damage and the corresponding implements of the crime.

How would you describe the typical surface condition of bones and tissue?

When investigating human or animal bones, we usually face rather difficult surfaces that show very steep flanks. Also, weapons or synthetics with reflecting metals were difficult to view and measure before we worked with

InfiniteFocus. This is the main reason why we purchased the Alicona measurement device. It is the perfect tool to measure in a high resolution even with difficult surface conditions.

What other surfaces are measured with InfiniteFocus?

As the system can be used for most surfaces we use it for various applications. Consequently, the type of materials investigated by InfiniteFocus is numerous and includes the 3D measurement of metals, wood, synthetics, bullets, tape, tissue, bones etc.

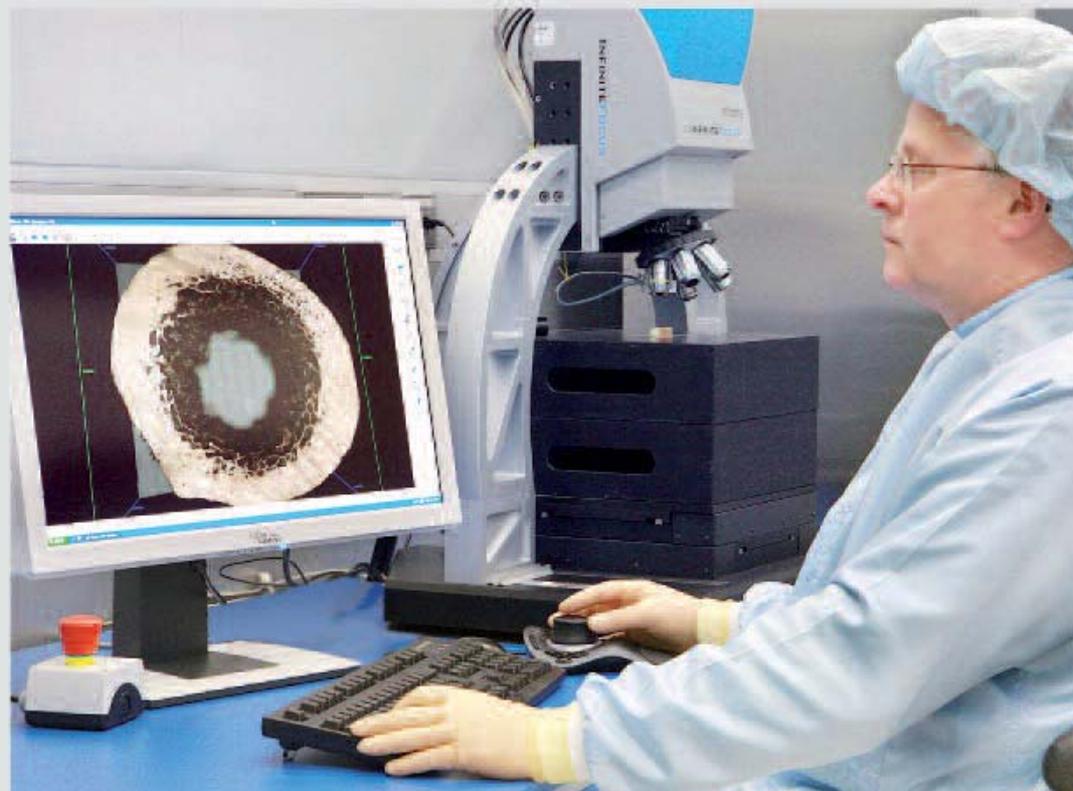
What are the special benefits of the system? What is in your opinion the most distinctive feature?

One of the most important aspects for our work is light and illumination. The combination of axial and ring light enables the high resolu-

tion measurement of the various reflective surfaces. Also, the system fills the gap between regular optical microscopes and the SEM. With InfiniteFocus, we are now able to measure down to a resolution of 10nm!

Is registered 3D color information offered by InfiniteFocus relevant to you?

This is definitely one of the most important features when it comes to reporting to judges, prosecutors, lawyers, police etc. Color information reinforces our findings and resulting conclusions.



René Pieterman

Department of Physical and Chemical Technology
Expertise Marks / Microanalyse Invasive Traumas

FULLY AUTOMATIC DIRECT ROUGHNESS AND SMOOTHNESS MEASUREMENT IN **PAPER AND PRINT INDUSTRY.**

The surface topography of paper provides information about its printability, its optical properties and about the potential printing quality. InfiniteFocus as a non contact optical measurement system measures directly also large areas and provides a correlation between the paper's surface roughness and its printability.

One of the most decisive factors of the papers' printability is its topography. Besides height differences and local "craters" of the surface, the smoothness highly influences the complete color application and quality of a print image. 3D measurements with InfiniteFocus are performed to significantly increase the paper's printability.

Use InfiniteFocus and obtain information about the printability of a surface.

The printability of paper is primarily dependent on the roughness of the surface. Traditional roughness measurement methods using indirect measurements of only one profile do not provide any information about its printability. Dr. Rainer Klein from the PTS Heidenau, Germany: "Traditional techniques such as Parker Print Surf or Bendtsen are not really appropriate for modern print techniques. This is due to the fact that they don't provide a real description of the surface on the basis of topographical parameters." In contrast, InfiniteFocus provides an "all inclusive" area based measurement of the surface: directly, and contact free. This provides a diagnostic and numeric characterization of the surface including the determination of the local homogeneity of the paper. Also, advanced quality assurance is provided as InfiniteFocus is used to verify

measures that are carried out to increase the paper's smoothness. This is how e.g. calendaring can be optimized on a numerical basis.

Even on highly reflective paper surfaces with steep slopes, Focus-Variation achieves a vertical resolution of up to 10nm. 3D measurements are performed directly on the optical color image. This is because both the topographic and color information are registered to the 3D data file. With two mouse clicks a profile is extracted across the measurement region. This visual correlation between the color image and the areal 3D depth information make the measurement with InfiniteFocus precise, significant, flexible and self-explanatory. InfiniteFocus not only measures along a single profile but on an areal basis. The following information can be obtained:

- » Amplitude parameters for the description of height distribution
- » Spectral analysis with auto correlation parameters
- » Gradient distribution for identifying the frequency and distribution of certain surface characteristics
- » Fast Fourier Transformation (FFT) for the analysis of marks on the surface

The optical 3D measurement device InfiniteFocus provides the ability of comprehensive areal measurement of coated and uncoated paper.

The topography of paper has an impact on the results of several manufacturing processes, for example on the final print quality.

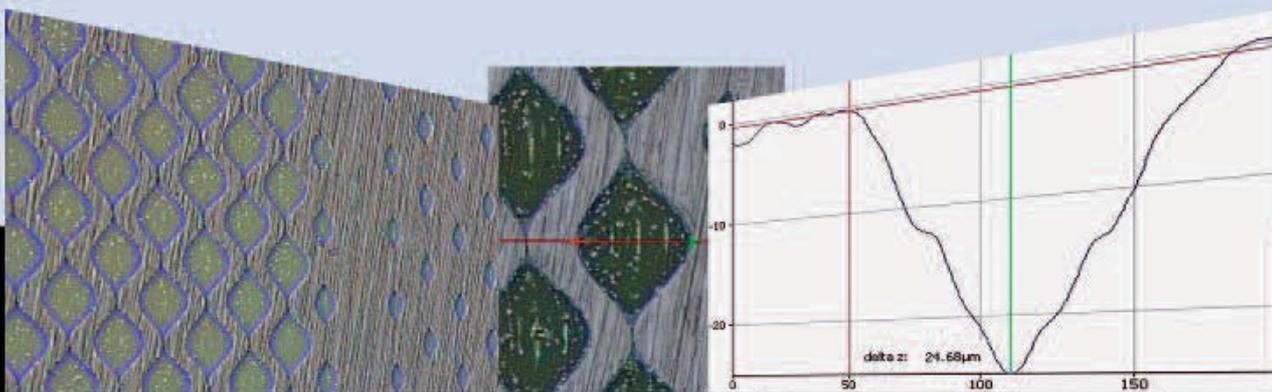
In the case of graphic papers for offset and gravure printing, insufficient paper topography affects the quality of print results. Indirect measurement techniques such as Parker Print Surf or Bendtsen are commonly used even though they are not really appropriate for modern printing techniques. This is due to the fact that they provide no real descriptions of the actual paper surface based on topographical parameters.

With InfiniteFocus we are able to measure the real roughness at high vertical resolution and obtain very detailed information about the topography of papers. In addition, the brilliant depth of focus is an excellent tool for efficient troubleshooting.

Dr. Rainer Klein

Competence Centre for Surface Finishing
and Functional Surfaces,
PTS Heidenau

PTS THE PAPER TECHNOLOGY SPECIALISTS



InfiniteFocus is also used to measure the pits on a gravure cylinder.

The depth and width of the pits can confirm if a uniform application of ink is possible.

CUSTOMIZED MEASUREMENTS WITH

Special measurement tasks need special measurement solutions. This is why Alicona offers the X-Large series of InfiniteFocus to characterize surfaces that are not suitable for the standard measurement system due to shape, size or weight of components to be measured. **X-Large** devices have a different look but offer the same benefits as the standard system: high vertical resolution of even complex forms with steep flanks, measurement of surfaces with varying material and reflection properties and registered color information with each measurement.

All **InfiniteFocus X-Large** variants offer the same functionalities and measurement capabilities as the standard measurement device InfiniteFocus. As soon as components are too large or too heavy, the X-Large series becomes relevant. This is achievable as the core technology Focus-Variation can easily be extended or adopted into another hardware platform. As with InfiniteFocus standard, all X-Large variants allow area based measurements with high measurement point density and high repeatability. Users reach a vertical resolution of up to 10nm even across large measurement volumes. Several options for automation increase user friendliness and efficiency.

There are various systems offered with different XY travel ranges and a maximum weight of components. The currently available spectrum of InfiniteFocus X-Large solutions includes travel ranges from (mm) 300 x 300 up to 1000 x 1000 with a maximum measurable weight of up to 200 kg. On request, systems with an increased weight capacity are possible.

Typical applications are e.g. the automatic defect analysis of large measurement fields or form measurement of laser structured geometries on e.g. printing plates. In general, each solid material is measurable as soon as there is a minimum surface roughness of only a few nanometers.



InfiniteFocus X-LARGE



SPECIFICATIONS INFINITEFOCUS XL 320

Dimensions	1100mm x 760mm x 1100mm
Weight of system	400kg
Max. lateral travel range (x/y)	320mm x 320mm
Max. vertical travel range (z)	100mm
Max. sample height	100mm*
Max. sample weight	10 kg

* can be extended

SPECIFICATIONS INFINITEFOCUS XL 650

Dimensionen	1435mm x 630mm x 1360mm
Weight of system	478kg
Max. lateral travel range (x/y)	650mm x 650mm
Max. vertical travel range (z)	100mm
Max. sample height	100mm*
Max. sample weight	10 kg**

* can be extended

** load must be centered

SPECIFICATIONS INFINITEFOCUS XL 1000

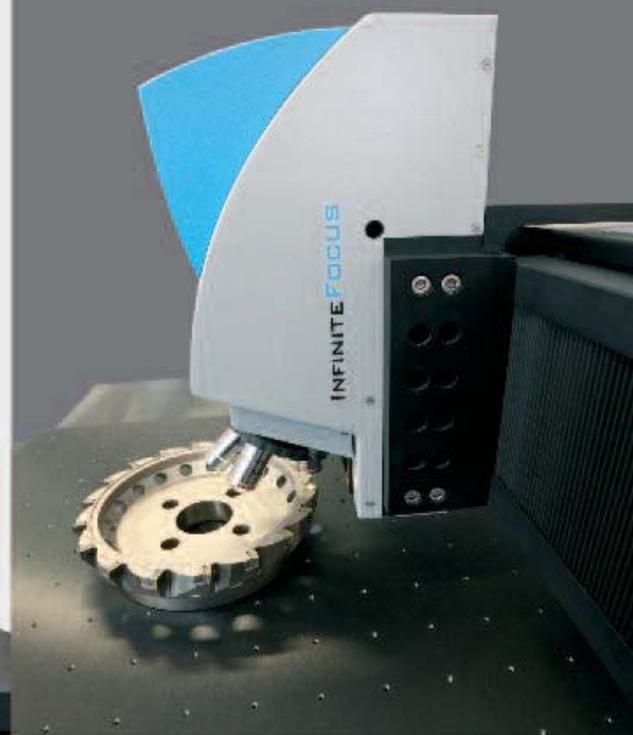
Dimensions	1680mm x 785mm x 1700mm
Weight of system	1100kg
Max. lateral travel range (x/y)	1000mm x 1000mm
Max. vertical travel range (z)	100mm
Max. sample height	100mm*
Max. sample weight	200 kg
Max. sample dimensions	1100mm x 1500mm

* can be extended



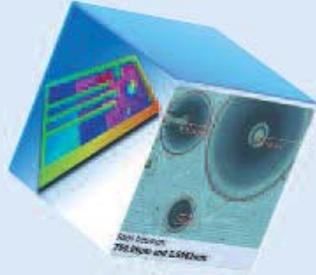
MEASUREMENT WITH EXTRAS

Both the InfiniteFocus standard system and the X-Large series for the characterization of measurement fields larger than 10cm x 10cm are easily adoptable to particular environments and/or new conditions. This means that not only the hardware can be changed to meet new requirements, but also the software is extendable individually with additional software modules. As Focus-Variation allows the quick and simple implementation of new software modules, InfiniteFocus is future proof to undertake new or changing measurement tasks. This is valid for standard software modules and for new custom designed modules on request. **Packages are available for the groove measurement on golf clubs, measurement of diamond particles, valve inspection, conrod and cam inspection etc.**



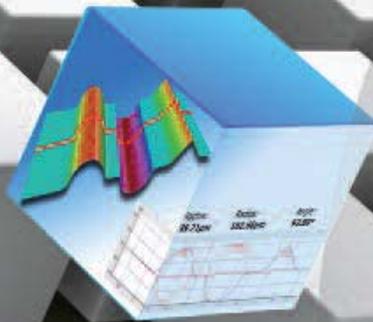
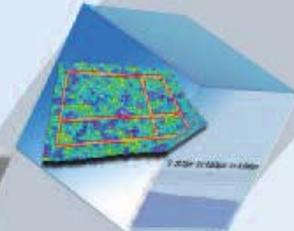
MEASUREMENT MODULES

FOLLOW THE STANDARDS. THE **INFINITEFOCUS** MEASUREMENT RESULTS GO CONFORM TO THE FOLLOWING STANDARDS (AS OF SPRING, 2010)



ISO 25178 - 6
VDI/VDE 2617- 6.2
ISO 4287
ISO 4288
ISO 11562
ISO 5436 - 1
ISO/TS 16610 - 1
ISO/TS 16610 - 20

ISO 25178 - 2
ISO 13565 - 2
ASME B46.1
ISO/TS 12180 - 1
ISO/TS 12180 - 2
ISO/TS 12181 - 1
ISO/TS 12181 - 2



Separate measurement modules provide the tools for complete surface measurement.

For all measurement modules, InfiniteFocus provides an in-depth definition of the geometrys' coordinate system. In addition, a variety of form removal utilities is available for professional form and roughness measurement. This allows a simple, accurate and repeatable surface measurement on complex components. All measurement modules are easy and intuitive to use throughout the well prepared graphical visualization and several export functionalities.

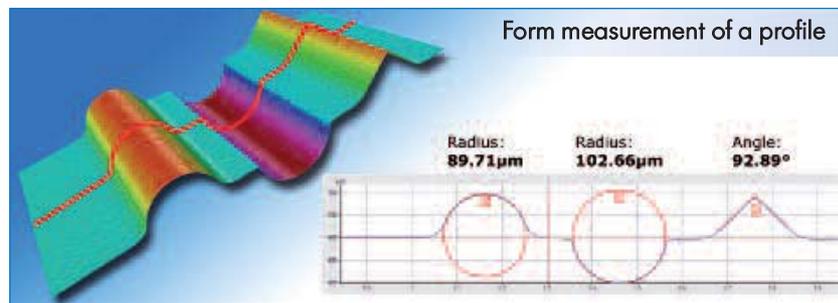
STANDARD MEASUREMENT MODULES OF INFINITEFOCUS ARE:

- » Profile-Form measurement
- » Profile-Roughness measurement
- » Surface-Texture measurement
- » Volume measurement
- » 2D image measurement
- » Automation

FORM MEASUREMENT OF A PROFILE

Form measurement along a user defined profile.

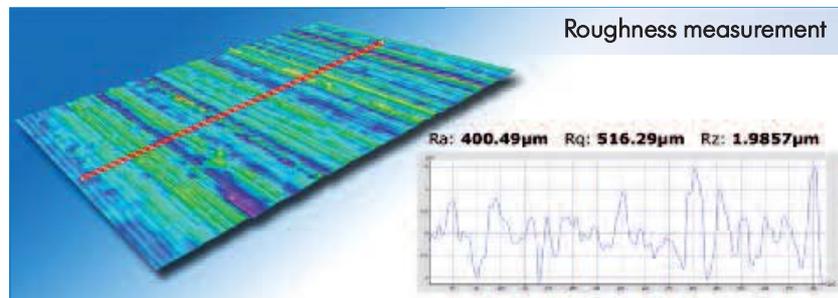
Measure radii, angles, height steps and normal distances manually or automatically.



ROUGHNESS MEASUREMENT

Classic roughness measurements conforming to EN ISO 4287, 4288.

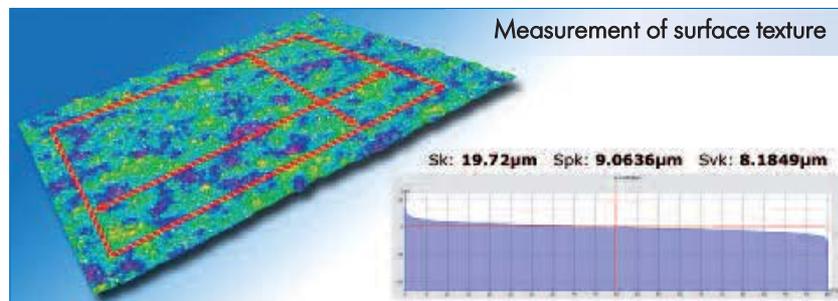
The roughness is measured with comprehensive parameter evaluation of roughness, waviness and frequency. Statistical evaluations and the bearing ratio curve or spectral analysis are graphically visualized.



MEASUREMENT OF SURFACE TEXTURE

Measurement conforming to EN ISO 25178.

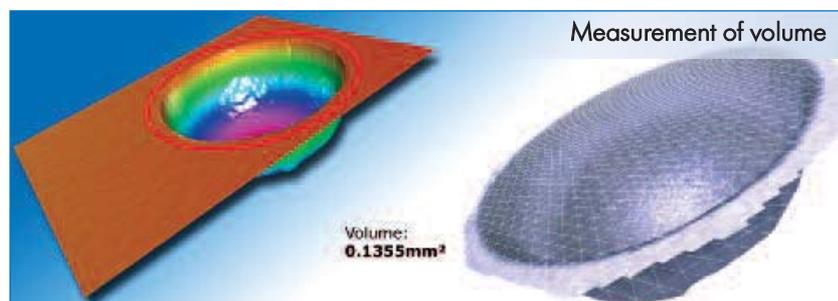
Measurement of several common surface parameters including statistical evaluation of bearing area curve, fractal dimension, autocorrelation, gradient distribution, local homogeneity and spectral distribution.



MEASUREMENT OF VOLUME

Quantification of pits or peaks.

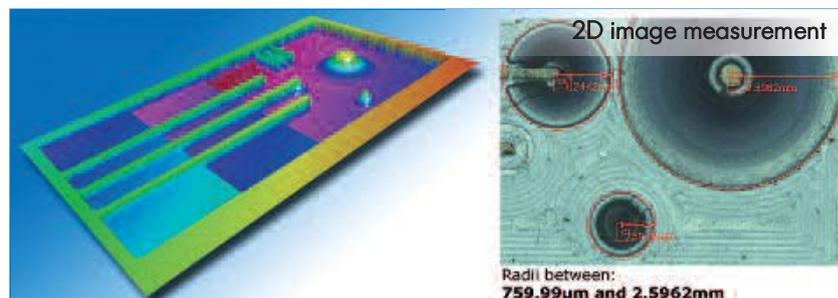
The volume is measured according to a user defined border. The extensive positioning of cutting layers or cutting surfaces provide a universal tool.



2D IMAGE MEASUREMENT

Evaluation of 2D-geometries.

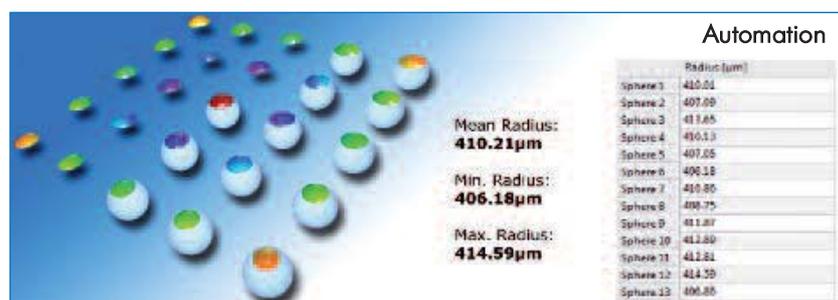
In the 2D-view of the measured surface features such as circles, straight lines, angles, parallel lines, distances, ellipses, rectangles etc. can be measured.



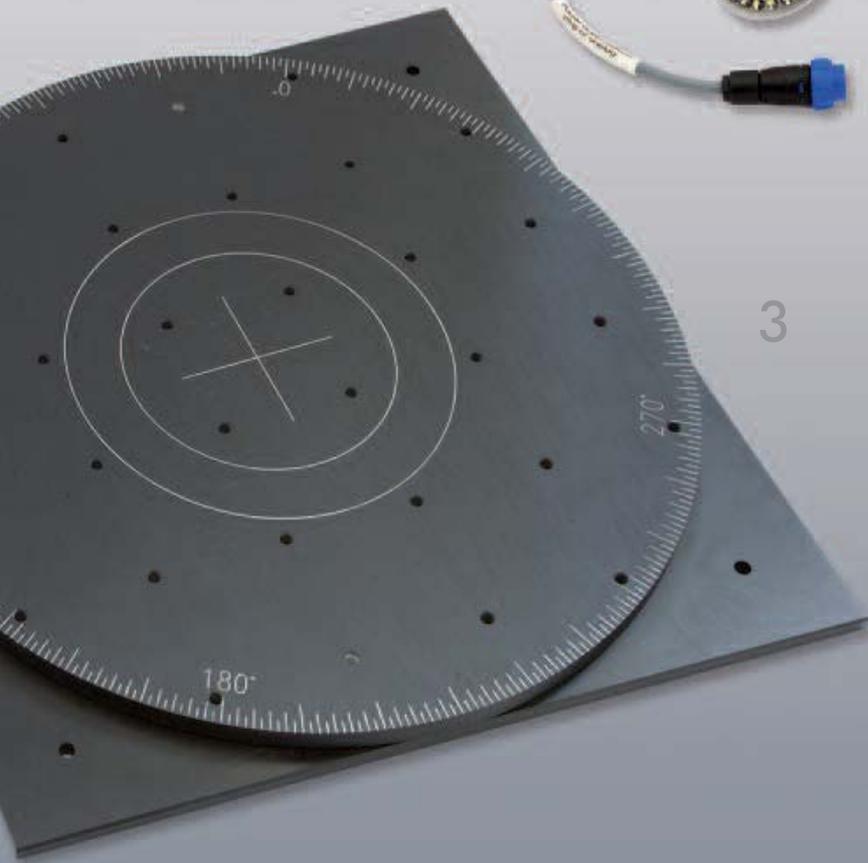
AUTOMATION

Programmable solution for repeating measurement tasks.

Several InfiniteFocus measurement applications are programmable, from a simple profile form measurement to more complex hardware control.



ADD ONS



1 CLAMPING-SET

A set of different clamping bars for mounting and securing specimens in a certain position: A flexible solution for flat, steep and round components.

2 CALIBRATION-TOOL

Standard, traceable to the PTB, for verifying the vertical and lateral accuracy of InfiniteFocus. It provides a height step (1000µm) for the vertical check and various chess patterns for the verification of lateral results.

3 ROTATION-TABLE

A rotation table for aligning components along x- or y-axis of the system. Ideal for the measurement of horizontal or vertical grooves and small ImageFields. A time saving device.

4 RING LIGHT

Additional light source for improved illumination. Especially useful on very complex surfaces enabling measurements in more detail.

5 VERIFICATION-TOOL

Standard, traceable to the PTB, with miscellaneous form artifacts such as steep slopes, angles and cylinder sizes. Used for verifying the accuracy of form measurements.

6 ROUGHNESS-STANDARD-500

Roughness standard for optical and tactile measurements traceable to the PTB. Used to verify the accuracy of optical roughness measurements. All ISO classified optical measurement techniques are validated.

7 ADVANCED-INSERT-GRIP

Grip for the measurement of small objects in variable oblique positions. This grip can be adjusted to most specimens and also locked in the desired position. Measurement comfort and repeatability are increased.

8 INSERT-GRIP

A tool for placing small components in an exact 45° position. This minimizes sources of error and increases repeatability.

9 REAL3D-ROTATION-UNIT

Add-on for the automatic rotation of components for up to 360° measurements. When used in combination with the various measurement modules, Real3D allows surface measurements from every perspective. With only one measurement the complete 3D dataset is available.

10 ROTATION-GRIP

Clamping device, for horizontal mounting of components such as drills or milling cutters enabling it to be rotated into the desired position. Also cutting edges are measured easily.

11 SPACER-PLATE

Height extension for the X/Y-stage. Especially for roughness measurements a stable positioning can be ensured. The Spacer-Plate is available in two different heights: 17.5mm and 35mm.



THE TECHNOLOGY: FOCUS-VARIATION

InfiniteFocus is based on the principle of Focus-Variation; a stable technology with high measurement point density and an inclusive measurement uncertainty matrix for lab and production.

"The optical measurement technique still has to face many challenges. However, Focus-Variation fulfills some of them already today. The measurement technique by Alicona achieves for example high resolution measurements in high speed. Most characteristic is the combination of a micro coordinate measurement system with the option for area based measurements."

*Prof. Richard Leach,
Principal Research Scientist, NPL*

"A MEASUREMENT VALUE WITHOUT MEASUREMENT UNCERTAINTY IS USELESS!"

Dr. Ulrich Neuschaefer-Rube, PTB

The measurement uncertainty is an essential part of any measurement value. This is why Focus-Variation provides information of the repeatability of every single 3D-point. Therefore the user gets an estimated measurement uncertainty with every measurement value.

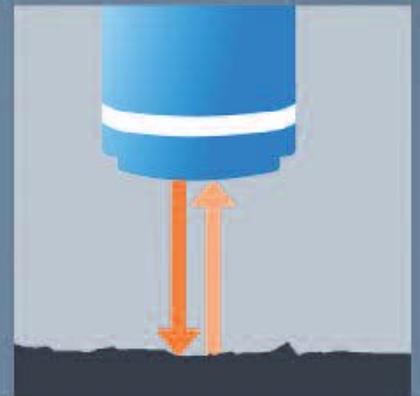
Dr. Ulrich Neuschaefer-Rube, PTB:

"At present, I have no knowledge of another measurement method which provides information to evaluate the quality of a measurement value."

InfiniteFocus provides high resolution and reproducible measurement results in the lab and in rougher manufacturing environments.

» The technology works reliably and is not affected by environmental influences such as temperature or ambient light. This is due to the large amount of data that is used for measuring every single z-value.

» InfiniteFocus is a high quality measurement device and generally insensitive to external influences. The system includes a vibration absorption construction and is therefore vibration resistant.



How Focus-Variation works

The specimen is placed onto the stage and is illuminated with modulated light. This light is transmitted through the optic and focused through a beam splitter onto the specimen. Coaxial illumination is created.

The light is reflected by the specimen and projected on to a digital sensor in the precision optic. Depending on the objective selected various lateral and vertical resolutions can be achieved.

MEASUREMENT POINT DENSITY AND REPEATABILITY

A large number of dense measurement points, also on larger areas, provides highly repeatable measurements.

Alicona also automatically provides an estimation of the repeatability of every single measurement value analyzing the variance of each measurement point in the z-direction.

This repeatability measure helps to evaluate the quality of individual measurement points. This again allows measurement results that are easy to interpret. In addition it shows if and to which extent vibrations occurred during the measurement.

» Various light sources minimize the impact of light.

» InfiniteFocus delivers an estimation of the measurement uncertainty for every 3D-point.

INFINITEFOCUS:

Dr. Manfred Prantl,
Alicona, CEO for Research and Development

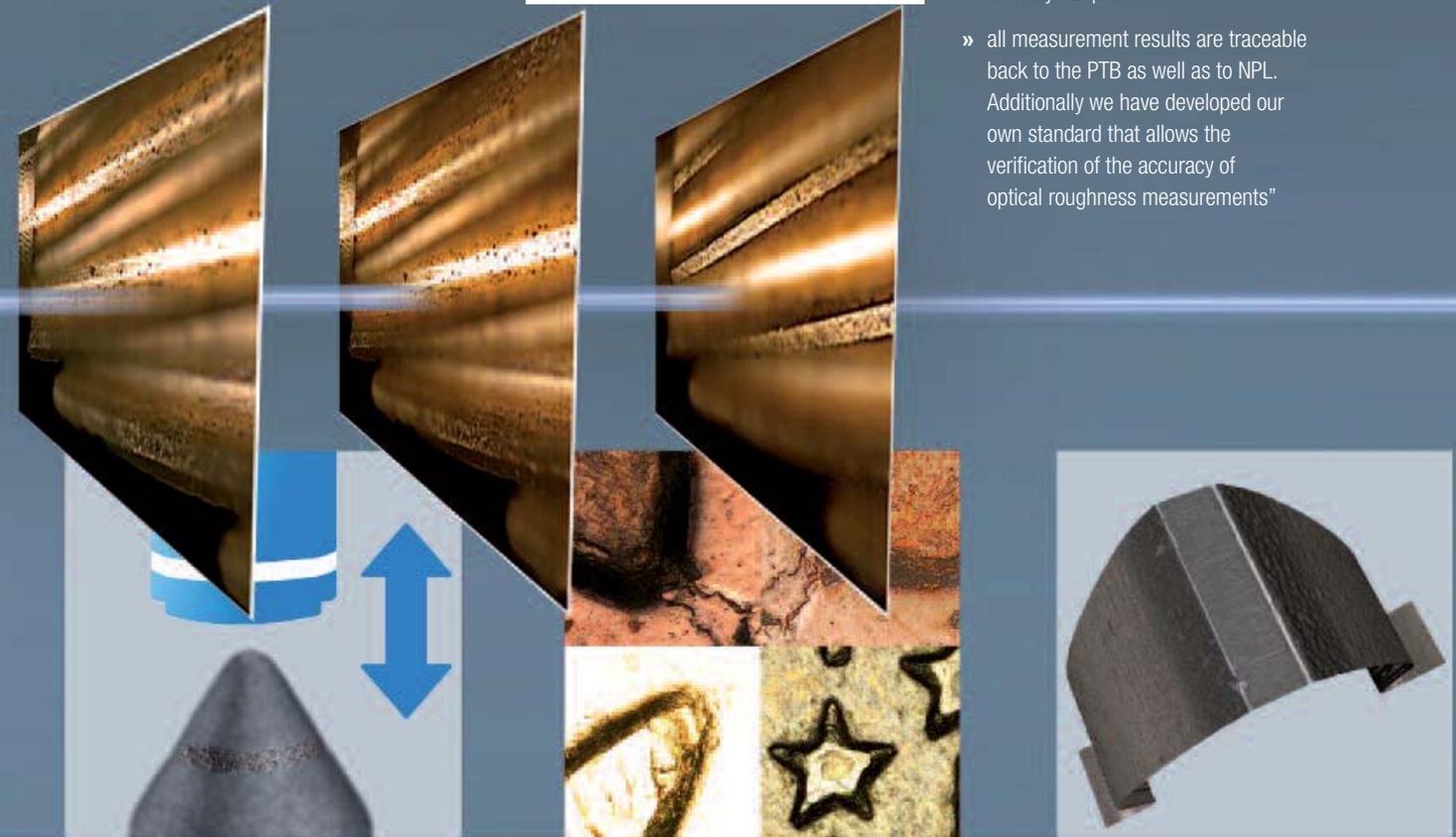
"Security and reliability are the cornerstones in each development. We develop with high investment in R&D, ensuring that we can tackle the needs required in industry and science.

» our technical specifications guarantee versatility and precision

» the use of InfiniteFocus is easy to understand even though it allows a variety of different settings

» InfiniteFocus delivers unambiguous results including information about the measurement uncertainty of every 3D-point

» all measurement results are traceable back to the PTB as well as to NPL. Additionally we have developed our own standard that allows the verification of the accuracy of optical roughness measurements"



As the distance between specimen and objective is varied the change of sharpness is measured. Depending on the 3-dimensional structure of the specimen some areas are depicted sharp or not, the sharp data is used to construct the 3D dataset.

Essential to the measurement result is the correct interaction of modulated illumination with continuous vertical movement and the quality of the sensor measurement. This process is achieved with the SmartFlash technology developed by Alicona.

For every position on the object the sharp regions are measured. The variation of the sharpness values is used for the measurement of the 3D-position. This is how dense 3D-datasets are created.

TECHNICAL SPECIFICATIONS

GENERAL SPECIFICATIONS

Measurement principle	<i>non-contact, optical, 3 dimensional, based on Focus-Variation</i>
Measurement result	<i>2-100mio 3D points in registered true color information (maximum is dependent on the used measurement module)</i>
Maintenance	<i>maintenance free</i>
Illumination	<i>white LED coaxial light, high power, controllable; Optional: white LED ring light, controllable, polarization</i>
Nosepiece	<i>6 objectives manual or motorized</i>
Travel range	<i>X:100mm, Y:100mm, Z:100mm</i>
Weight	<i>95-100kg, depending on equipment</i>
Size measurement system WxDxH	<i>710mm x 540mm x 628mm (up to 868mm)</i>
Temperature range	<i>possible: 5° - 40°C, calibrated for: 18° - 22°C (other temperature ranges can be calibrated)</i>
Temperature gradient	<i>less than 1° per hour</i>
Power supply	<i>900W;110-230V~; 50-60Hz</i>
Size ControlUnit WxDxH	<i>540mm x 682mm x 360mm</i>

SPECIMEN

Specimen surface texture	<i>surface topography Ra above 10-15nm with a Lc of 2µm, surface structure dependent</i>
Max. height of specimen	<i>100mm up to 240mm</i>
Max. weight of specimen	<i>35kg, more on inquiry</i>
Maximum slope angle	<i>up to 85°</i>
Sample preparation	<i>none</i>

OBJECTIVES

Objectives		2,5x	5x	10x	20x	50x	100x
Lateral sampling distance	<i>µm</i>	<i>3.52</i>	<i>1.76</i>	<i>0.88</i>	<i>0.44</i>	<i>0.18</i>	<i>0.09</i>
Min. lateral resolution	<i>µm</i>	<i>58.71</i>	<i>23.48</i>	<i>11.74</i>	<i>8.8</i>	<i>6.4</i>	<i>4.4</i>
Max. lateral resolution	<i>µm</i>	<i>6.92</i>	<i>3.49</i>	<i>1.75</i>	<i>0.88</i>	<i>0.64</i>	<i>0.44</i>
Min. repeatability (vert.)	<i>µm</i>	<i>0.8</i>	<i>0.12</i>	<i>0.03</i>	<i>0.015</i>	<i>0.008</i>	<i>0.003</i>
Max. scan height (approx.)	<i>mm</i>	<i>8</i>	<i>22</i>	<i>16</i>	<i>12</i>	<i>9</i>	<i>3.2</i>
Scan speed*	<i>µm/s</i>	<i>2300</i>	<i>400</i>	<i>100</i>	<i>50</i>	<i>20</i>	<i>10</i>
Best vertical resolution**	<i>nm</i>	<i>2300</i>	<i>410</i>	<i>100</i>	<i>50</i>	<i>20</i>	<i>10</i>
Vertical dynamic		<i>3400</i>	<i>52000</i>	<i>160000</i>	<i>250000</i>	<i>430000</i>	<i>380000</i>
Working distance	<i>mm</i>	<i>8.8</i>	<i>23.5</i>	<i>17.5</i>	<i>13.0</i>	<i>10.1</i>	<i>3.5</i>
Field of view X	<i>µm</i>	<i>5716</i>	<i>2858</i>	<i>1429</i>	<i>715</i>	<i>286</i>	<i>143</i>
Field of view Y	<i>µm</i>	<i>4351</i>	<i>2175</i>	<i>1088</i>	<i>544</i>	<i>218</i>	<i>109</i>
Max. extended field of view Y	<i>mm²</i>	<i>10000</i>	<i>10000</i>	<i>10000</i>	<i>4500</i>	<i>700</i>	<i>150</i>
Max. uni-directional scan extension	<i>mm</i>	<i>100</i>	<i>100</i>	<i>100</i>	<i>100</i>	<i>100</i>	<i>100</i>

*) The maximum scan speed is not achieved by every application.

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

SOFTWARE

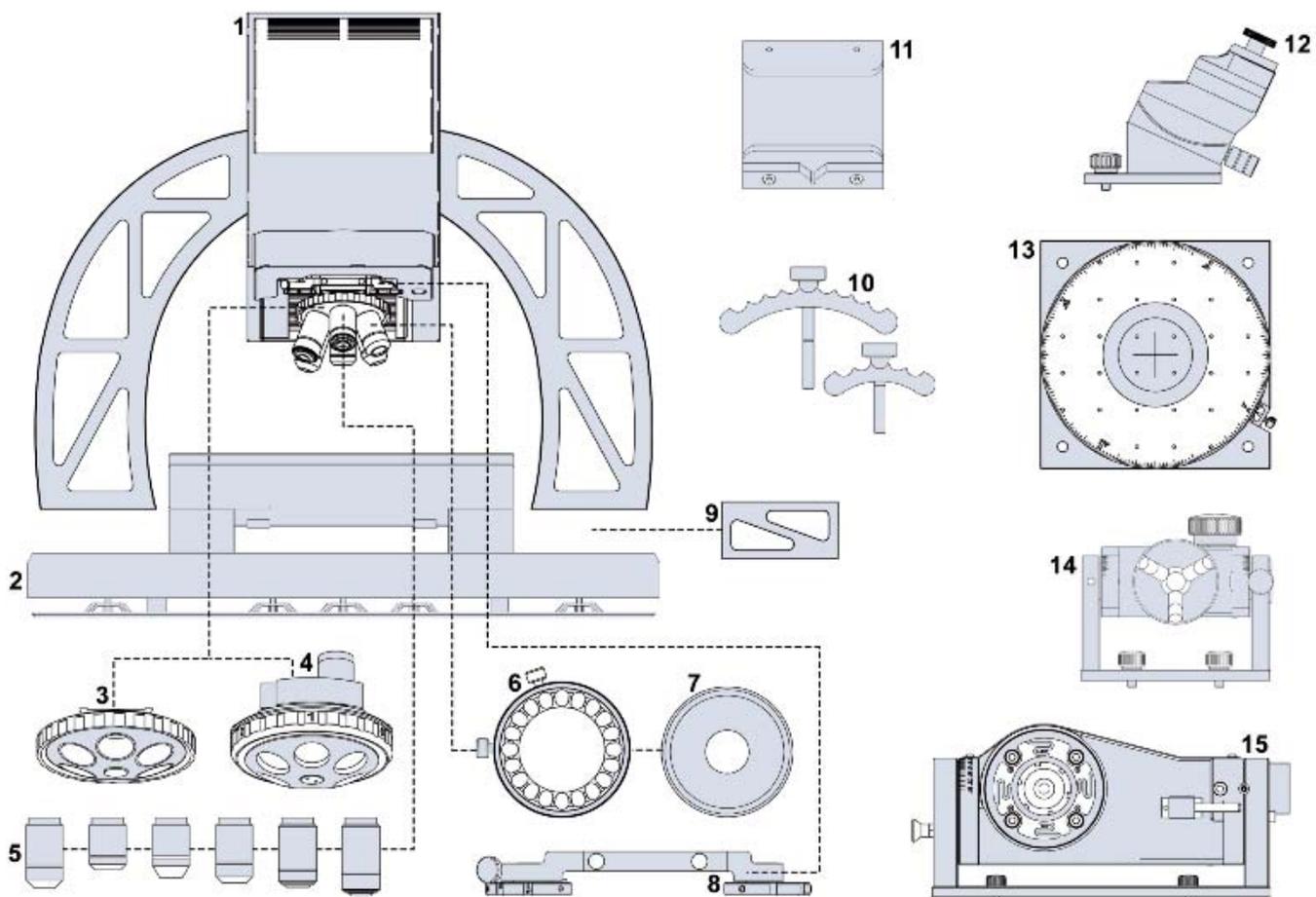
Measurement modules and utilities	<i>Standard: ProfileFormMeasurement (height, angle...), ProfileRoughnessMeasurement (Ra...), SurfaceTextureMeasurement (Sa, fractale dimension...), VolumeMeasurement, 3D-Editor, FormRemoval; Optional: 3DFormMeasurement, DifferenceMeasurement, ContourMeasurement, EdgeMeasurement;</i>
Automation	<i>IF Automation (built-in script editor), .NET Remoting interface</i>
Visualization	<i>2D-image and high resolution 3D visualization</i>
Database	<i>intuitive, graphical database</i>
Import/Export	<i>Simple export to STL and VRML, import of CAD-data with STL format, QDAS export, variety of reporting functionalities</i>
Available in	<i>German, English, Korean, Japanese</i>

RESOLUTION AND APPLICATION LIMITS

Objectives		2,5x	5x	10x	20x	50x	100x
Min. measurable height	nm	2300	410	100	50	20	10
Max. measurable height (approx.)	mm	8	22	16	12	9	3.2
Step height accuracy (1mm height step)	%	-	0.05	0.05	0.05	0.05	0.05
Max. measurable area	mm ²	10000	10000	10000	4500	700	150
Max. measurable profile length	mm	100	100	100	100	100	100
Min. repeatability	nm	800	120	30	15	8	3
Min. measurable roughness (Ra)*	nm	7000	1200	300	150	60	30
Min. measurable roughness (Sa)*	nm	3500	600	150	75	30	15
Min. measurable radius	μm	20	10	8	5	2	1
Min. measurable vertical angle	°	20	20	20	20	20	20

The entries in the table are traceable values.

*) The minimum measurable values are dependent on the structure of the specimen.



(1) Sensor head and stiffened sensor ribs (2) passive vibration damping and x-y-stage (3) manual nosepiece (4) motorized nosepiece (5) 2.5x, 5x, 10x, 20x, 50x and 100x objective (6) ring light (7) polarization disc for ring light (8) polarization for coaxial light source (9) height extension* for larger specimens (10) ClampingSet (11) InsertGrip (12) AdvancedInsertGrip (13) RotationTable (14) RotationGrip (15) Real3DRotationUnit

*) can only be changed by certified Alicona service engineers

MEASUREMENT WITH **INFINITEFOCUS**

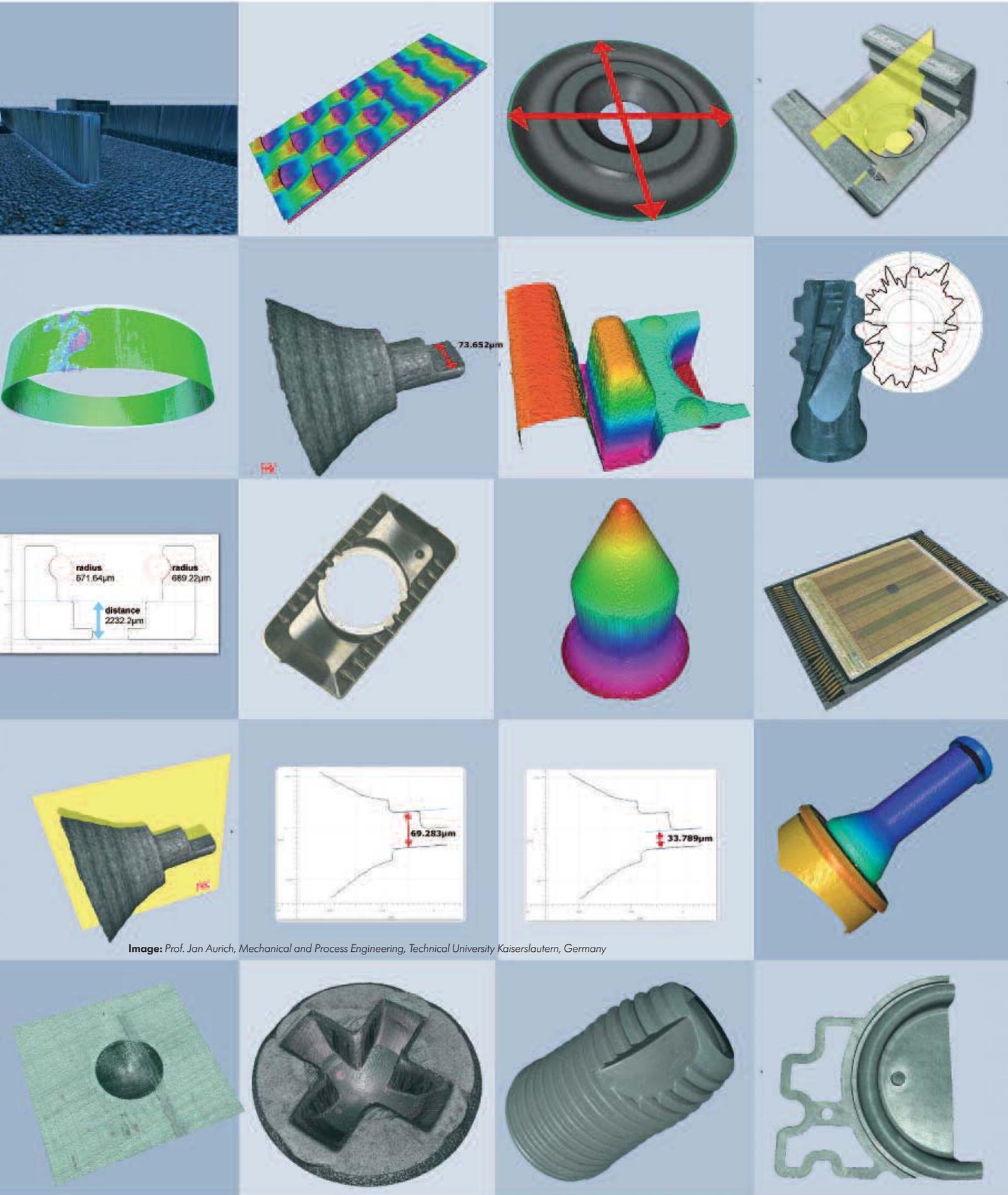


Image: Prof. Jan Aurich, Mechanical and Process Engineering, Technical University Kaiserslautern, Germany

FRAUNHOFER VISION ALLIANCE

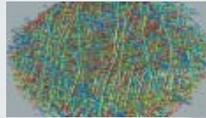
RESEARCH AND DEVELOPMENT FOR INDUSTRIAL QUALITY INSURANCE

The Fraunhofer *Vision* Alliance pools the expertise of the Fraunhofer Institutes in the fields of machine vision, image processing, optical testing and measurement.

Competences of Fraunhofer *Vision*

- Inspection and characterization of surfaces
- Analysis of microstructures
- Systems for optical 3-D-measurement
- Heat flux thermography and x-ray techniques for invisible defects
- X-ray tomography (CT) for analysis and measurement of hidden structures
- Terahertz tomography

By request, complete solutions including the handling system are provided. A strong cooperation network with *Vision* partners from industry and science completes these abilities. Alicona is a partner of the Fraunhofer *Vision* Alliance since 2006.



The central office of the Fraunhofer *Vision* Alliance in Erlangen functions as a contact point and offers a first counselling to all questions concerning image processing.

Possibilities of cooperation

- Technological counselling
- Preliminary studies and feasibility analysis
- Introduction and testing of new technologies
- Development of orders through to turnkey systems
- Further development and optimization
- Measurement and test services
- Further education, workshops and supplementary services
- Joint projects and cooperations



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Bass



Ceratizit



EDM



ETH



Fette



FZG



Fraunhofer Vision



Fraunhofer IPK



Heidelberg



Inspire



MAKINO



NFI



NPL



oerlikon



PTB



PTS



SIMTEK



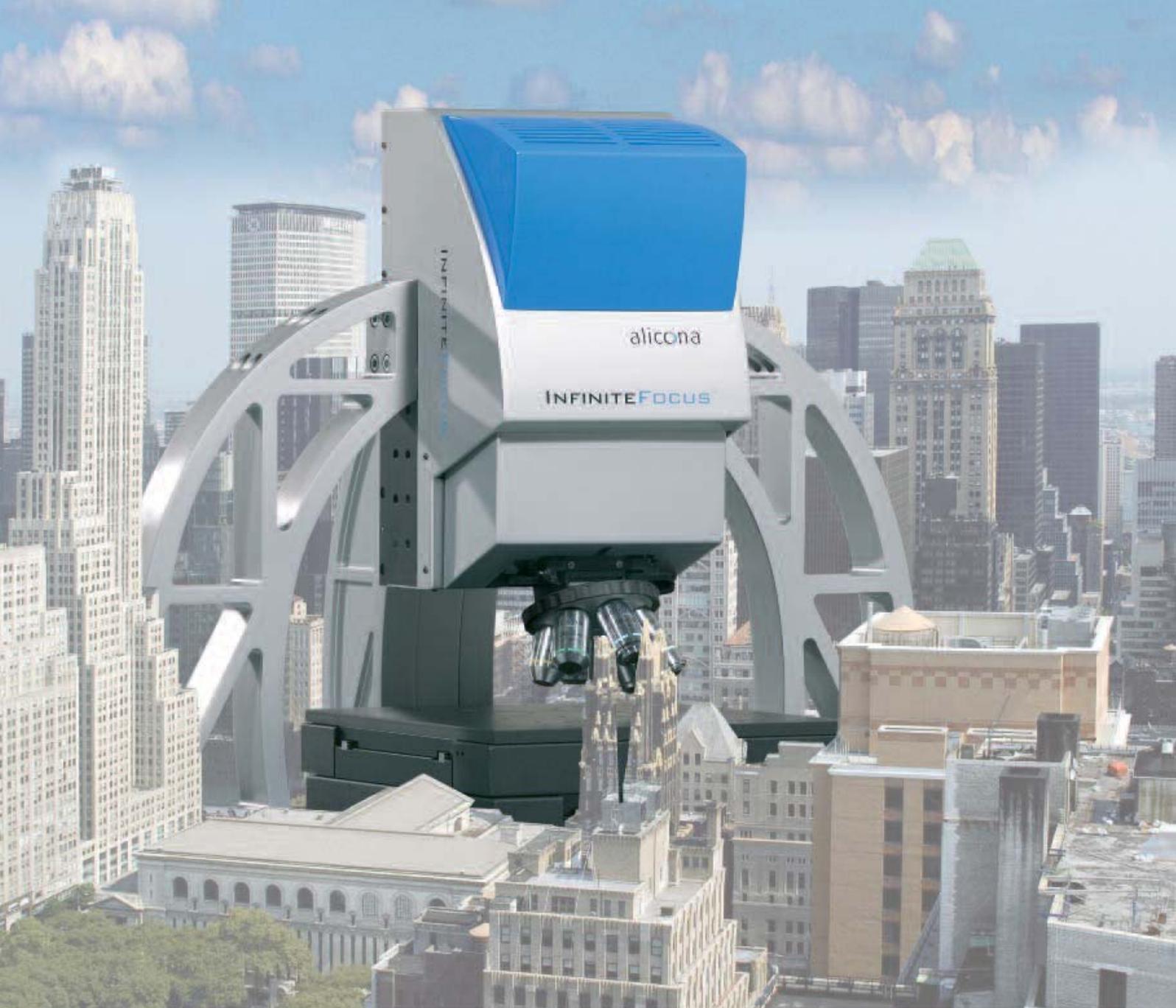
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