MEASUREMENT IN FOCUS

MEASURE FORM AND ROUGHNESS IN ONLY ONE SYSTEM

INFINITE FOCUS
PROVABLE
PRECISION

OPTICAL MEASUREMENT IN PRODUCTION

INFINITE FOCUS VARIATIONS
# Table of content

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<table>
<thead>
<tr>
<th>Section</th>
<th>Pages</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>INTRODUCTION</strong></td>
<td>4 – 7</td>
</tr>
<tr>
<td><strong>FROM EXPERIENCE</strong></td>
<td>8 – 13</td>
</tr>
<tr>
<td><strong>OPTICAL MEASUREMENT IN PRODUCTION</strong></td>
<td>16 – 17</td>
</tr>
<tr>
<td><strong>MEASUREMENT MODULES</strong></td>
<td>18 – 19</td>
</tr>
<tr>
<td><strong>TECHNOLOGY</strong></td>
<td>20 – 21</td>
</tr>
<tr>
<td><strong>SOFTWARE SPECIFICATIONS</strong></td>
<td>22 – 23</td>
</tr>
<tr>
<td><strong>INFINITE FOCUS REAL3D</strong></td>
<td>24 – 25</td>
</tr>
<tr>
<td><strong>MEDICAL DEVICE</strong></td>
<td>26 – 27</td>
</tr>
<tr>
<td><strong>MATERIAL SCIENCE</strong></td>
<td>28 – 29</td>
</tr>
<tr>
<td><strong>MICRO SYSTEMS TECHNOLOGY</strong></td>
<td>30 – 31</td>
</tr>
<tr>
<td><strong>MICRO ELECTRONICS</strong></td>
<td>32 – 33</td>
</tr>
<tr>
<td><strong>POLYMER &amp; MOLDING</strong></td>
<td>34 – 35</td>
</tr>
<tr>
<td><strong>FORENSIC</strong></td>
<td>36 – 37</td>
</tr>
<tr>
<td><strong>PAPER AND PRINT</strong></td>
<td>38 – 39</td>
</tr>
<tr>
<td><strong>IF-SENSOR, IF-PORTABLE, IF-ROBOT &amp; IF-EDGEMASTER</strong></td>
<td>40 – 41</td>
</tr>
<tr>
<td><strong>PROVABLE PRECISION</strong></td>
<td>42 – 43</td>
</tr>
<tr>
<td><strong>INFINITE FOCUS ADDONS</strong></td>
<td>44 – 45</td>
</tr>
<tr>
<td><strong>THE PRINCIPLE OF FOCUS-VARIATION</strong></td>
<td>46 – 47</td>
</tr>
<tr>
<td><strong>TECHNICAL SPECIFICATION INCL. EXPLODED VIEW</strong></td>
<td>48 – 49</td>
</tr>
</tbody>
</table>

**Table of content:**

- **INTRODUCTION**
  - Pages 4 – 7
- **FROM EXPERIENCE**
  - Pages 8 – 13
- **OPTICAL MEASUREMENT IN PRODUCTION**
  - Pages 16 – 17
- **MEASUREMENT MODULES**
  - Pages 18 – 19
- **TECHNOLOGY**
  - Pages 20 – 21
- **SOFTWARE SPECIFICATIONS**
  - Pages 22 – 23
- **INFINITE FOCUS REAL3D**
  - Pages 24 – 25
- **MEDICAL DEVICE**
  - Pages 26 – 27
- **MATERIAL SCIENCE**
  - Pages 28 – 29
- **MICRO SYSTEMS TECHNOLOGY**
  - Pages 30 – 31
- **MICRO ELECTRONICS**
  - Pages 32 – 33
- **POLYMER & MOLDING**
  - Pages 34 – 35
- **FORENSIC**
  - Pages 36 – 37
- **PAPER AND PRINT**
  - Pages 38 – 39
- **IF-SENSOR, IF-PORTABLE, IF-ROBOT & IF-EDGEMASTER**
  - Pages 40 – 41
- **PROVABLE PRECISION**
  - Pages 42 – 43
- **INFINITE FOCUS ADDONS**
  - Pages 44 – 45
- **THE PRINCIPLE OF FOCUS-VARIATION**
  - Pages 46 – 47
- **TECHNICAL SPECIFICATION INCL. EXPLODED VIEW**
  - Pages 48 – 49
Editorial

Every day we are exposed to an overwhelming flood of information. Additionally, globalized economy requires instant decisions to be made. The correct focus can easily be lost or shifted towards the wrong direction.

Your focus is the constant manufacturing of high quality products and innovative R&D. Metrology is one of many tools you need in order to reach these goals. The better the tool, the faster you are on track and the more effective your result will be. But how to find the correct and lasting solution out of the flood of information and existing technologies?

With the first issue of FOCUSvariation, the magazine presenting the InfiniteFocus product line, we showcase the focus of our work. We claim to provide you with comprehensive information offering a substantial basis for a fast, reasonable and lasting decision. The presentation style in the format of a high quality magazine emphasizes our outstanding innovation in both our products and marketing.

Enjoy reading the first issue about InfiniteFocus and evolutionary measurement!
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.
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
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 Mio 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
“INFINITE FOCUS 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 INFINITE FOCUS 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

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.”
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 10 nm 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.”
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 consistent 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.”

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.”

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.”
WHAT DOES THE OPTICAL MEASUREMENT DEVICE INFINITEFOCUS WITH ITS TACTILE SYSTEM OPPONENT HAVE IN COMMON WITH A GAME OF CHESS:

The strength of a player in chess is reflected in both his strategy and overview. This is followed by quick results with precise movements to win the match. A simple handling of figures, opportunities and settings increases flexibility and dedication. And who is not fast or precise enough loses with checkmate.
WHY THE TACTILE MEASUREMENT TECHNIQUE IS MORE OFTEN IN CHECK.

NO WEAR
Measure always like on day one.

The precision of InfiniteFocus measurements is a constant. The results are completely independent from wear and usage. Instead: Long life is assured at constant accuracy.

MODULAR AND EXPANDABLE
Simply individual.

Different measurement tasks require individual solutions. For that reason Alicona offers a basic configuration of InfiniteFocus. Its functionality can be extended by various specimen grips and additional measurement modules (such as the difference measurement of two 3D datasets and for wear and contour measurement). Also Alicona original add-ons such as various tools and traceable standards are available. These allow the user to verify the accuracy of the measurement results.

STABLE AND ROBUST
A real survivor.

Focus-Variation is a stable technology that offers high accuracy measurements in rough and demanding environments. A robust chassis with integrated vibration absorption ensures a minimization of external influences as dust or vibrations.

CHANGING OBJECTIVES WITHOUT CALIBRATION
Automatic.

For a quick change between a detail and an overview objectives do not need to be exchanged. A manual nosepiece allows a rapid change of magnification without any contamination of the optics due to dust or other influences. For “deluxe” users the objectives can also be changed automatically with a motorized nosepiece.

SPECIAL SOLUTIONS
Nothing is impossible.

If an application cannot be achieved with the standard configuration Alicona offers extra large versions with travel ranges of 320 x 320, 650 x 650 and 1000 x 1000mm. Also custom solutions are offered for 3D measurement in production.

HIGH MEASUREMENT ACCURACY ON LARGE MEASUREMENT AREAS VIA REGISTERED TRUE COLOR INFORMATION
Traceable high precision.

Measure large areas in high resolution and error-free – what sounds provocative is simple for the Focus-Variation technique. Registered true color information of the 3D surface in combination with the high measurement point density allows an error-free combination of several single measurements. Instead of stitching errors, common in other techniques, InfiniteFocus delivers traceable precision.

DEVELOPED FOR AUTOMATION
Easily configurable software.

Measurement tasks are easily automated. Fractures, cracks, corroded surfaces etc. are detected, measured and quantified automatically. The statistical evaluation guarantees the accuracy of the results with clear data to show what the surface is like. The software has been developed in a way that the user can write his own program for his measurement task.

EASY TO USE
Everybody’s darling.

The use of the system is intuitive due to its easy handling and the excellent ease of use. The software design is logical and measurement results are well presented. Comprehensive export and print options for the measurement results and the well structured database complete the system.
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.”
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 2µm 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

“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
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 viewpoint. 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
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.

**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.

**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 Bäumler, 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 set actual 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 Bäumler.
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 Bäumler, research assistant at FZG says: “We are now able to measure areas that are not accessible by common tactile measurement 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 Bäumler. “This, for example, opens up the opportunity to perform deset-actual comparisons of tooth modifications. InfiniteFocus therefore closes the gap between the classical 3D coordinate measurement and roughness measurement techniques.”

**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 Bäumler, research assistant at FZG says: “We are now able to measure areas that are not accessible by common tactile measurement 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 Bäumler. “This, for example, opens up the opportunity to perform deset-actual comparisons of tooth modifications. InfiniteFocus therefore closes the gap between the classical 3D coordinate measurement and roughness measurement techniques.”

**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 Bäumler, FZG

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 Bäumler.
"With InfiniteFocus, I am able to measure, in a non-contact method, small radii of micro form elements and tools in a high resolution. It is fantastic how well this works. Also on micro structured surfaces, the form measurement results are outstanding and allow the measurement of micro milled surfaces with a depth of only 10µm. The combination of a surface measurement device and form analysis system has indeed been achieved."

Prof. Jörg Seewig, Head of Institute for Measurement and Sensor-Technology, TU Kaiserslautern
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 independently 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 INFINITYFOCUS 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
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.
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 areas 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.

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 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

“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

Sometimes, form has to “disappear” in order to measure the surface roughness. This is achieved by the InfiniteFocus measurement module “Form Removal.”
MEASURE - DON´T SNIFFLE AROUND!

INFINITE FOCUS

Human bone in 3D

Detail of knife-holder

Firing pin in 3D with registered color information

Volume measurement of a knife holder
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 kinds 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.

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 resolution 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.

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.
The inspection of missing dots is a standard application for InfiniteFocus. In the optical color image missing dots are clearly visible.
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 printing 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. calendering 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 autocorrelation 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 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 paperography 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

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.
Geometries have become smaller and more complex, tolerances tighter and process reliability has become a key question. Integrated quality assurance requires provable and traceable measurements. With InfiniteFocus, a non-destructive measurement solution is offered in various options. This is Alicona’s answer to the demand for faster, high resolution and traceable measurements.

The core of production integrated measurement with InfiniteFocus is always the Focus-Variation technology, with the “packaging” adjusted to the application. No matter which InfiniteFocus version is used – the individual use, depending on the application, provides certain synergies leading to cost effective measurement. For the user this means that minimum effort provides maximum quality assurance. Methods proved in development or in the lab are easily duplicated in-line. With its flexible and modular hardware system, InfiniteFocus bridges the gap between the lab and production.

The industrial capability of InfiniteFocus is based on the following facts:

» Simple automation of sensors on large measurement volumes with comfortable working distances
» Proven stable technology
» The effective export- and import functionality of data transfer allowing quick evaluation of measurement results irrespective of the operating conditions (external light, temperature fluctuations, vibration)
» Simple integration into the process due to clear and defined interfaces

“The request is straight-forward and challenging at the same time: Metrology used in research and quality assurance should be also applicable in production in an easy way.”

Dr. Stefan Scherer,
CEO Alicona

Special solutions for special applications:
The IF-XLarge 1000 system offers a travel range of 1000mm x 1000mm.

The IF-Robot measures roughness, form and geometry of large components such as aircraft turbines. Robot supported measurements also allow difficult to access surface characteristics to be quickly and easily measured.

IF-Portable is used for mobile applications. A movable measurement station that can be used wherever it is needed.
The IF-EdgeMaster automatically measures form, edge and radius of inserts in production. It offers easy handling with a special coarse drive that simplifies focusing on the insert.

The IF-Portable … is lightweight, robust, mobile, fast and cost effective. The system has been developed as a mobile and flexible measurement station which can be used wherever it is needed. It is available as an alternative to a permanently installed measurement solution. One of the most common fields where it is used is platen inspection. As for all InfiniteFocus systems the change of objectives is achieved with a nosepiece fitted with several objectives increasing the resolution of the measurement results. This removes error-prone adjustment and time consuming recalibration after an objective change becomes obsolete.

The IF-EDGEMASTER … is a system for fully automated measurements of form, edge radius and chipping on the edge of inserts in production. Clearance, wedge and chipping angle, chipping (and alternatively roughness), positive and negative bevel as well as basket arch form are measured.

As a real "production professional", the IF-EdgeMaster
» measures the edge in high resolution resulting in robust and accurate measurement of chipping edge and roughness

The InfiniteFocus standard system covers a measurement area of 10cm x 10cm. For the measurement of larger measurement fields, special solutions are available. The IF-XLarge series offer high resolution 3D measurement capabilities on larger and heavier components with the same accuracy and repeatability as the standard system.

THE IF-SENSOR … is “made to be tough”, temperature stable and insensitive to vibration. This makes the sensor suitable for production environments. Its high operating speed and large measurement range makes the sensor a universal system. Even on complex surfaces, large measurement areas and measurement volumes, both roughness and form are measured in high resolution. A strain-relieving plug on the sensor head with cables for drag chain use allows simple integration in production. The SmartFlash technology enables a vertical measurement speed of several mm per second across large measurement ranges. The fast cycle times make the IF-Sensor a versatile measurement device for production integrated quality assurance.

THE IF-ROBOT … measures roughness, form and geometry of large components such as aircraft turbines or engine blocks in high resolution. The measurement system combines the flexible positioning of a 6-axis robot with the measurement capacity of the optical sensor. The analysis of defects, tolerance and corrosion analysis are standard applications along with the measurement of orientation including the repositioning according to the CAD dataset. Using this, for example, laser based micro machining processes are assured.

THE IF-PORTABLE … is lightweight, robust, mobile, fast and cost effective. The system has been developed as a mobile and flexible measurement station which can be used wherever it is needed. It is available as an alternative to a permanently installed measurement solution. One of the most common fields where it is used is platen inspection. As for all InfiniteFocus systems the change of objectives is achieved with a nosepiece fitted with several objectives increasing the resolution of the measurement results. This removes error-prone adjustment and time consuming recalibration after an objective change becomes obsolete.

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MEASUREMENT MODULES

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

ISO 25178 - 6  ISO 25178 - 2
VDI/VDE 2617 - 6.2  ISO 13565 - 2
ISO 4287  ASME B46.1
ISO 4288  ISO/TS 12180 - 1
ISO 11562  ISO/TS 12180 - 2
ISO 5436 - 1  ISO/TS 12181 - 1
ISO/TS 16610 - 20

Separate measurement modules provide the tools for complete surface measurement.

For all measurement modules, InfiniteFocus provides an in-depth definition of the geometry’s 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.
We blindly trust in the precise timekeeping of a Swiss clock. In modern metrology, precision needs to be proved. Proving the measurement accuracy is achieved by traceable international reference standards. In the field of optical 3D measurement Alicona has set new standards of competence.

For a measurement to be trusted it must be repeatable and traceable. Only comparison with international established standards as e.g. of the Physikalisch Technische Bundesanstalt in Braunschweig, Germany (PTB – which is the national metrology institute providing scientific and technical services) or the National Physical Laboratory in Teddington, UK (NPL) can certify the accuracy of a measurement result. To be trusted, all measurements performed by InfiniteFocus are traceable back to reference standards by both institutions. Alicona has even gone further. By developing a traceable standard for optical roughness measurements, the supplier of optical 3D measurement solutions has set a milestone in optical metrology.

**Precision is not all. It must be traceable.**

The tactile measurement technique conforms to a number of established standards that confirm the accuracy of the measurements made. Also, these standards make tactile measurements trustworthy. However, tactile measurement techniques are not comprehensive enough for the micro structured surfaces that are produced nowadays, and, for optical measurement devices, standards for proving the accuracy have been missing.

Until recently there was no option available that allows tracing back the accuracy of an optical roughness measurement to a certified standard, instead it was common practice to use standards from tactile devices. Alicona CEO Dr. Stefan Scherer about this problematic practice: “Most standards are designed only for tactile sampling. To trace back an optical measurement by using a standard made for the tactile instrument class is a rather questionable venture. Two processes and techniques are mixed up that should be observed differently.” That is the reason why Alicona has taken care that this lack of appropriate standards is now no longer an issue. With its specially developed roughness

*“The traceability of measurement results to a common and well known reference is an absolute essential factor. Otherwise no significant comparison with other measured values, certified standards or well known thresholds or target values can be achieved. Without the traceability no binding statement can be made about the matching of two components.”*

Prof. Richard Leach, Principal Research Scientist, NPL
standard, which is traceable to the PTB, Alicona provides a standard for the whole branch. For the first time, there is a standard available that is appropriate for all optical ISO-certified measurement techniques. Prof. Jörg Seewig from the Institute of Measurement and Sensor-Technology at the Technical University Kaiserslautern, Germany sees that one of the most fundamental requirements for science and industry is fulfilled: “This new standard 100% fits to the needs of the optical measurement branch. With this standard Alicona has set a new milestone.”

“The optical measurement technique requires internationally valid standards and guidelines!”

With this standard, both industry and science, see one of their major requests fulfilled as it will boost the general acceptance and further development of optical measurement techniques. However, there still is a lot to be done: “Tactile measurements are trusted, as not only standards and guidelines are available, but also approved material standards. For optical measurements this trustworthiness is still missing, because at present only a few standards and guidelines exist and particularly often no appropriate material standards are available. This is one of the reasons why the user often cannot judge if the chosen system is the correct option for his application”, concludes Dr. Ulrich Neuschaefer-Rube from the Coordinate Metrology Department of the PTB. Since its foundation Alicona has been active in several important committees, commissions as well as in the ISO-federation. As a main driving force, the company essentially contributes to a worldwide positioning of optical measurement and increases its development and acceptance.

Prof. Dr. Jörg Seewig is head of the Institute for Measurement and Sensor-Technology at the Technical University Kaiserslautern, Germany. Here the expert and author of various publications expresses his views about the status quo of optical measurement in production.

“SOME TASKS CANNOT BE SOLVED BY TACTILE MEASUREMENT ANYMORE.”

It is a paradox: On one hand physical limits are being reached by tactile measurement systems. On the other hand, optical systems, that have not reached their limits, have not been widely taken up in integrated production measurement and quality assurance.

Why is this?

It is a fact that modern fine detailed functional geometries have become too complex to be measured with a tactile system. The results are simply not robust enough and vary depending on the measurement position.

Applications in the automotive sector, such as the measurement of cylinder walls, shafts and seals, typify the problem. A tactile system, for example, would damage a seal and would neither provide characterization data on a granular surface nor functional data on a honed surface. These measurement tasks can only be achieved by optical methods. More and more manufacturers recognize the possibilities provided by optical measurement techniques and have started to use these techniques for quality assurance. However, this is still more valid in the laboratory, rather than in production.

But why is it that optical measurement has been rarely used in a production near environment even though there is an increasing need to do so? Surprisingly, this is not a result of missing or not fully developed products or solutions; it is the result of inadequate strategies and standards to satisfy the users.
Tactile systems are well established and have a wide range of standards and reference tools making the methods comfortable to use with traceable results. But with optical measurement, efforts have not been completed to help the user decide which settings or parameters can be used to achieve optimal measurements.

For tactile instruments a number of standards and reference tools are available to verify the accuracy of measurement results, these standards are still needed in the world of optical instruments. Most companies have only focused on the development of their products, leaving out further aspects of providing usability such as guide lines and standardization. Only a few visionary forces from industry are looking beyond their technical horizons to counteract this drawback. Thanks to them necessary standardization is slowly but surely being reviewed in international committees. With EN ISO 25178 first steps have been made. Hopefully these driving forces keep going and ensure that in near future optical measurement techniques will also find its true place in production.

“Thanks to some visionary driving forces the necessary standardization is being created. This will make optical measurement accepted both in production and integrated quality assurance.”

Prof. Dr. Jörg Seewig
Institute for Measurement and Sensor Technology at the Technical University Kaiserslautern, Germany.
RING LIGHT
Additional light source for improved illumination. Especially useful on very complex surfaces enabling measurements in more detail.

POLARISATION
Option for filtering out reflections. Allows the measurement of surfaces with varying reflective properties and steep flanks.

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.

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.

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.

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.

REAL3D-ROTATION-UNIT
Add-on for the automatic rotation of specimens for up to 360° measurement. 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.
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 A MEASUREMENT UNCERTAINTY IS USELESS!”

Dr. Ulrich Neuschafer-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 Neuschafer-Rube from the PTB: “I do not know of any other technology that delivers at this time information to verify the quality of a measurement value as it is achieved by Focus-Variation.”

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.

» Various light sources minimize the impact of light.

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

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.
Prof. Dr. Jörg Seewig
is chair person of the Institute for Measurement and Sensor-Technology at the Technical University Kaiserslautern, Germany.

He is convinced that a “stable measurement system” must ...

» fulfill technical specifications that guarantee that the measurement task can be solved
» support intuitive and easy to use interfaces
» deliver unambiguous, precise and significant results that do not allow any space for interpretation
» offer information about measurement uncertainty (a so called measurement uncertainty matrix) for every measurement value
» provide results that are traceable back to certified standards (NPL, PTB…)

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.

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”
TECHNICAL SPECIFICATIONS

GENERAL SPECIFICATIONS

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

SPECIMEN

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

OBJECTIVES

<table>
<thead>
<tr>
<th>Objective</th>
<th>2.5x</th>
<th>5x</th>
<th>10x</th>
<th>20x</th>
<th>50x</th>
<th>100x</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lateral sampling distance</td>
<td>µm</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Min. lateral resolution</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Max. lateral resolution</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Min. repeatability (vert.)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Max. scan height (approx.)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Scan speed*</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Best vertical resolution**</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Vertical dynamic</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Working distance</td>
<td></td>
<td></td>
<td></td>
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<td></td>
<td></td>
</tr>
<tr>
<td>Field of view X</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Field of view Y</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Max. extended field of view Y</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Max. uni-directional scan extension</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

*) 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

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

<table>
<thead>
<tr>
<th>Objectives</th>
<th>2.5x</th>
<th>5x</th>
<th>10x</th>
<th>20x</th>
<th>50x</th>
<th>100x</th>
</tr>
</thead>
<tbody>
<tr>
<td>Min. measurable height</td>
<td>nm</td>
<td>2300</td>
<td>410</td>
<td>100</td>
<td>50</td>
<td>20</td>
</tr>
<tr>
<td>Max. measurable height (approx.)</td>
<td>mm</td>
<td>8</td>
<td>22</td>
<td>16</td>
<td>12</td>
<td>9</td>
</tr>
<tr>
<td>Step height accuracy (1mm height step)</td>
<td>%</td>
<td>-</td>
<td>0.05</td>
<td>0.05</td>
<td>0.05</td>
<td>0.05</td>
</tr>
<tr>
<td>Max. measurable area</td>
<td>mm²</td>
<td>10000</td>
<td>10000</td>
<td>10000</td>
<td>4500</td>
<td>700</td>
</tr>
<tr>
<td>Max. measurable profile length</td>
<td>mm</td>
<td>100</td>
<td>100</td>
<td>100</td>
<td>100</td>
<td>100</td>
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<tr>
<td>Min. repeatability</td>
<td>nm</td>
<td>800</td>
<td>120</td>
<td>30</td>
<td>15</td>
<td>8</td>
</tr>
<tr>
<td>Min. measurable roughness (Ra)</td>
<td>nm</td>
<td>7000</td>
<td>1200</td>
<td>300</td>
<td>150</td>
<td>80</td>
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<tr>
<td>Min. measurable roughness (Sa)</td>
<td>nm</td>
<td>3500</td>
<td>600</td>
<td>150</td>
<td>75</td>
<td>30</td>
</tr>
<tr>
<td>Min. measurable radius</td>
<td>µm</td>
<td>20</td>
<td>10</td>
<td>8</td>
<td>5</td>
<td>2</td>
</tr>
<tr>
<td>Min. measurable vertical angle</td>
<td></td>
<td>20</td>
<td>20</td>
<td>20</td>
<td>20</td>
<td>20</td>
</tr>
</tbody>
</table>

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 INFINITE FOCUS

Bildquelle: Prof. Jan Aurich, Fertigungstechnik und Betriebsorganisation, Technische Universität Kaiserslautern
Advanced surface texture measurements

Surface texture measurements benefit manufacturers in identifying process changes and how a part will function in use. NPL offers both contact and non-contact surface texture measurements.

NPL's surface texture measurement service offers:
- Profile and areal surface texture measurements on industrial components
- Calibration artefact supply and measurement compliant to ISO standards
- Flexibility in application of surface measurements from machined parts and optics to wafers for microelectronics and MEMS
- Reference software for testing parameter algorithms.

For further details please visit 
www.npl.co.uk/engineering-measurements
or email dimensional_enquiries@npl.co.uk

| Bass Ceratizit EDM Department Inc. ETH |
|--------------------------------------|-------------------------------------|
| Fette FZG inspire NFI |
| NPL oerlikon PTB PTS |
| TU Hamburg Harburg TU Kaiserlautern Universitätsklinikum Tübingen |

This is a selection of InfiniteFocus users who have contributed to the first issue of FOCUS:variation