English edition 7

The magazine about Alicona-metrology

alicona

focus variation

Collaborative systems with

Alicona Cobots

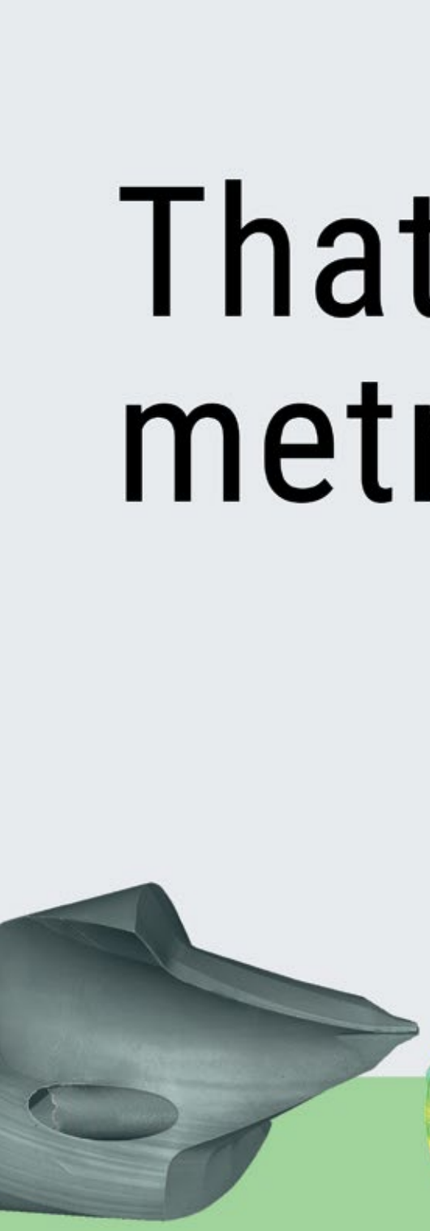
Real3D

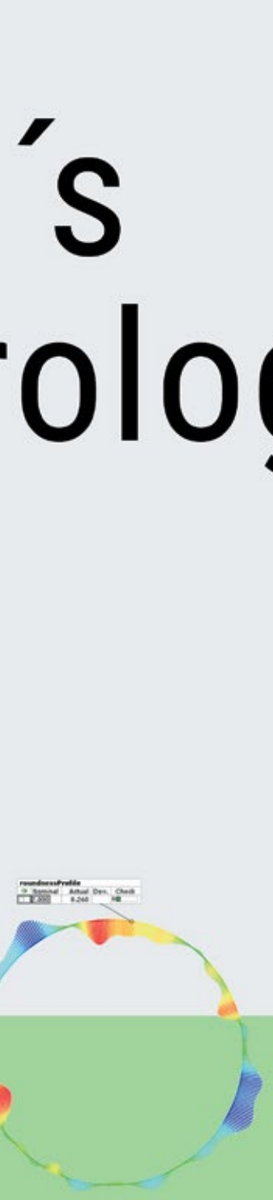
Full form measurement of complex components

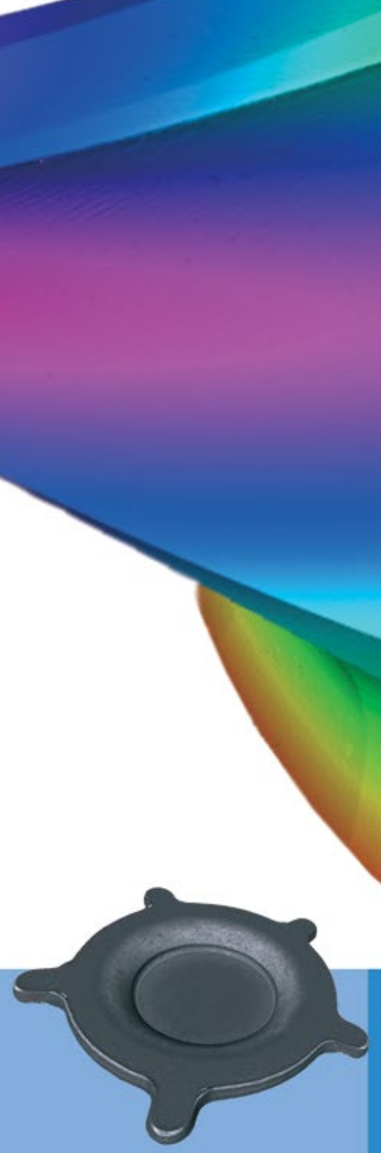
Smart Manufacturing

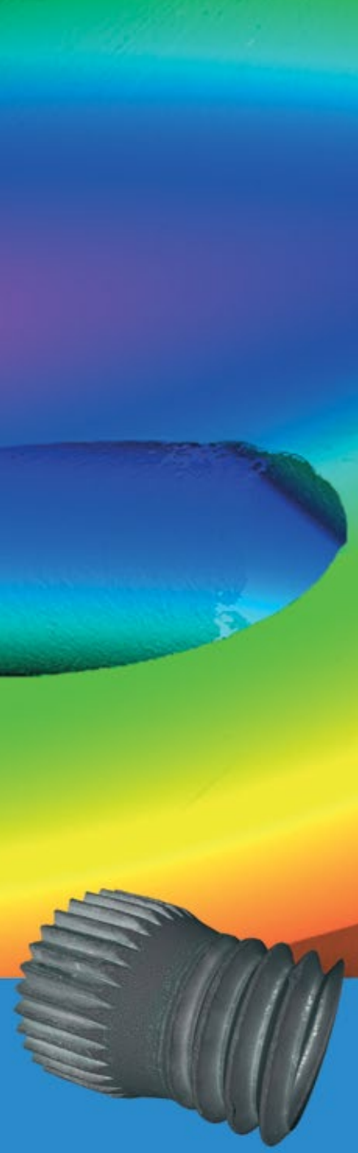
When 3D measurement becomes the smart eye for production

That´s metrology!









Dr. Manfred Prantl,
Alicona CEO

Dr. Stefan Scherer,
Alicona CEO

Highest demands

The intelligent fusion of production and optical 3D measurement is one of our highest demands. Since our foundation in 2001 we have been enhancing high resolution optical 3D measurement based on our Focus-Variation technology to be fit for production.

What began in 2009 with the introduction and constant expansion of the EdgeMaster product series for quality assurance in production, progressed to the next step in 2014 with Closed Loop Manufacturing and led to the consistent further development of our current solutions in production measuring technology for industrial quality assurance.

With this new, 7th edition of FOCUSvariation, the magazine about Alicona´s high-resolution optical 3D measurement, we show you how we have professionalized our mission and which solutions we offer today so you can meet the requirements for smaller quantities, tighter tolerances and higher precision in your production. Welcome to the age of Smart Manufacturing, where quality assurance is not only faster and safer but also more precise and flexible!

"Faster" does not only mean a higher measuring speed, but also the possibility to integrate optical measuring sensors including automatic measuring data processing into production. We implement this using an automation interface and a CAD CAM connection. Flexibility is created through various possibilities to integrate high-resolution measuring sensors into an existing manufacturing line. The latest example is the new ToolCobot from the fast growing product series of collaborative systems that we will also present to you in this edition. Precision is provided through measurement automation and user-independent operation.

Only then, reproducibility as well as sustainable evaluation of a manufacturing process is possible in the first place.

What is your highest demand?
Realize it with us!
Enjoy reading,

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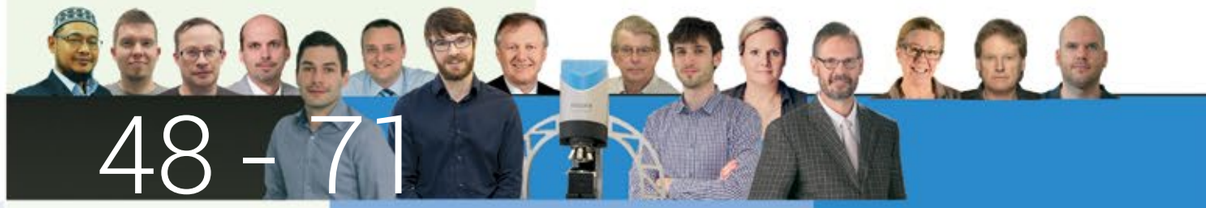

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Markets

Key markets and applications

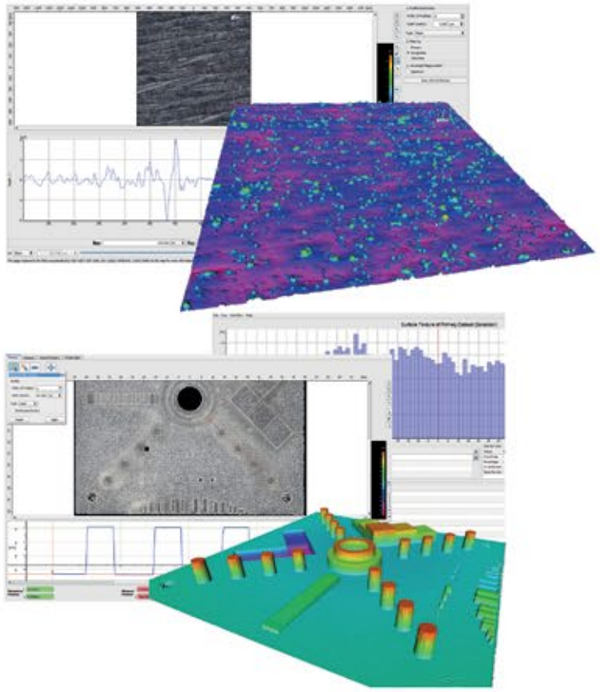
The application areas of Alicona optical 3D metrology are manifold. Users benefit from automated, traceable and repeatable 3D measurements in a laboratory as well as in production. The optical high-resolution measurements enable manufactures to verify accuracy of machining centers and achieve higher reproducibility of processes and products. That way, Alicona supports users in increasing reliability of processes while retaining a high degree of standardization.

Additive Manufacturing

- Optimization of 3D printing process
- Quality assurance of additive manufactured parts
- Surface texture measurement for quality evaluation of entire surface
- Analysis of porosity throughout volume measurement (Vvc, Vmc)
- Automatic measurements to identify form deviations to CAD dataset or reference geometry
- 3D measurements to achieve optimum finishing process, e.g. polishing

"Our Alicona system has proved invaluable for analysis of the complex surfaces generated by laser processes such as additive manufacturing and high precision manufacturing, providing reliable measurements when other instruments struggle."

***Duncan Hand,** Director, EPSRC Centre for Innovative Manufacturing in Laser-based Production Processes (CIM-Laser), School of Engineering and Physical Sciences*



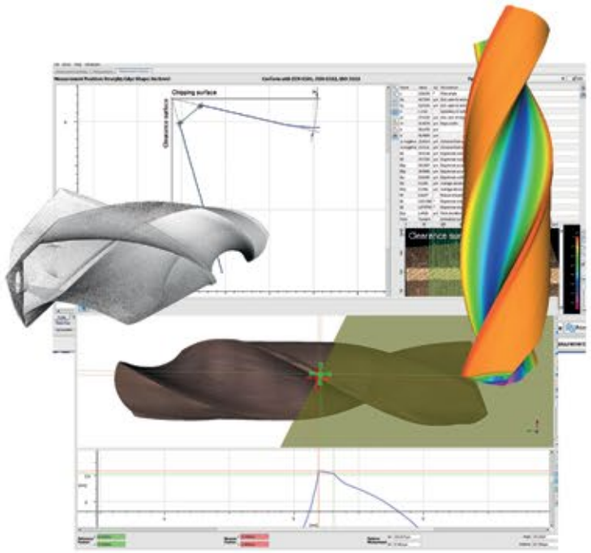
EPSRC Centre for Innovative Manufacturing in LASER-BASED PRODUCTION PROCESSES

Tool Industry

- Verification of cutting edge preparation
- Definition of correct machining parameters such as feed rate and cutting speed
- Surface finish measurement to determine cutting quality
- Ideal chip removal throughout areal roughness measurement in the flute
- Quantification of droplets for improved coating processes proved through areal roughness measurements
- Detection of edge chipping throughout profile roughness measurement
- Verification of bevel geometry
- Full form measurement with Real3D technology
- Complete Reverse Engineering

"The Alicona technology plays in important role in developing our next generation of products."

***Anders Ivarsson,** Specialist, Geometric Measuring Technology, Sandvik Coromant R&D*



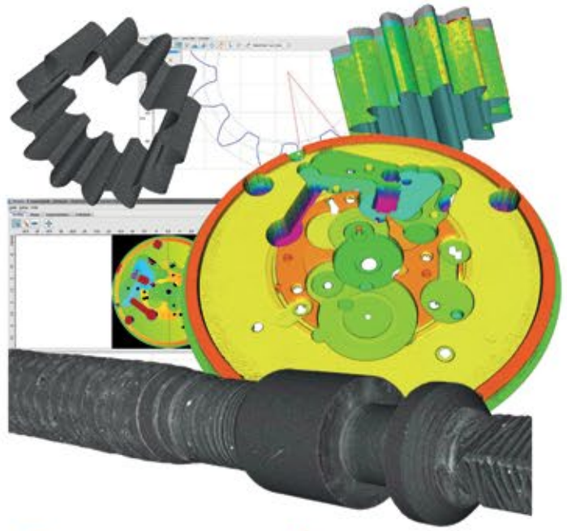
KENNAMETAL BASS TECHNIK FÜR GEWINDE SANDVIK Coromant

Micro Precision Manufacturing

- Automatic measurement of micro gears; includes area based measurement and verification of the entire tooth flank of all teeth
- Measurement of complex shapes with small radii and angles even at high measurement volumes
- Determination of shape and roughness via large lateral and vertical scanning areas within one single measurement process
- Checking and verification of dimensional accuracy and finish quality
- Measurement of composites with various materials and reflective properties
- Failure analysis, incoming goods inspection and integrated tools compensation
- 3D measurement of dies, quality assurance in stamping and forming technologies

"We mainly use Alicona's option of full form measurement. And we believe that Alicona has no competition in this field. "

***Frank E. Pfefferkorn**, Associate Professor, Mechanical Engineering, University of Wisconsin-Madison*



MAKINO pure perfection FRENCO SARIX

Markets

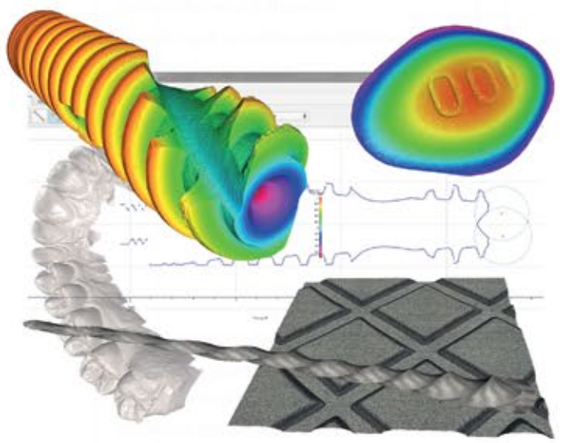
Key markets and applications

Medical Technology and Pharmaceutics

- High resolution measurement of dental implants'roughness, including those on thread roots
- Quality assurance of orthodontic brackets
- Complete form measurement of surgical drills, milling cutters, etc.
- High-resolution measurements of knee, hip or spinal disc implants
- Establishing a measurable correlation between surface quality and biological behavior of implants
- Measurement of pills and capsules: Simple and visible verification against imitations, determination of slip properties through area-based measurement of surface characteristics
- Quality assurance of packaging products and materials (e.g. aluminium blister packaging)
- Verification of surface finish and quality of surgical instruments and instrument tables
- Quality assurance of blister machines and components, e.g. sealing tools, heating plates and sealing rollers
- Optical measurement and inspection of needle protection for syringes, fusion tubes and other materials produced by means of plastic injection molding

"I can rely on Alicona regarding not only precise measurement but expert application knowledge as well!"

Josef Meisler, *Quality Engineering, Alpha Bio Tec*

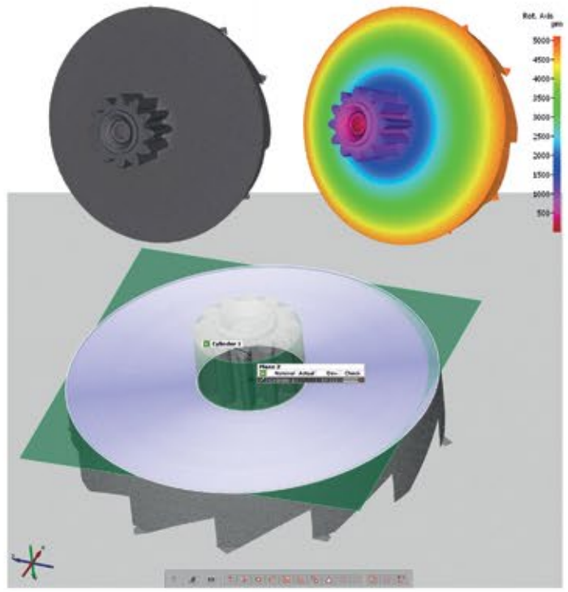


Injection Molding

- Optimized mold making through electrode savings of more than 10%
- Quality assurance of micro molds and molds in precision manufacturing
- Geometry measurement of both electrode and eroded mold
- Verification of surface finish throughout areal surface texture measurement
- Process optimization, e.g. optimized separation behavior, prevention of sink marks and joint lines
- Numerical verification of geometric deviations of the colded part from the injection mould

"With our machining centers we help our customers to eliminate manual rework as both, the accuracy of the contour and surface quality of the cavity achieved is superior. At this level it is tough to measure the quality, though. With Alicona we have a partner who helps us to prove it."

Andreas Walbert, *Head of Marketing and Product Planning, Makino Europe*

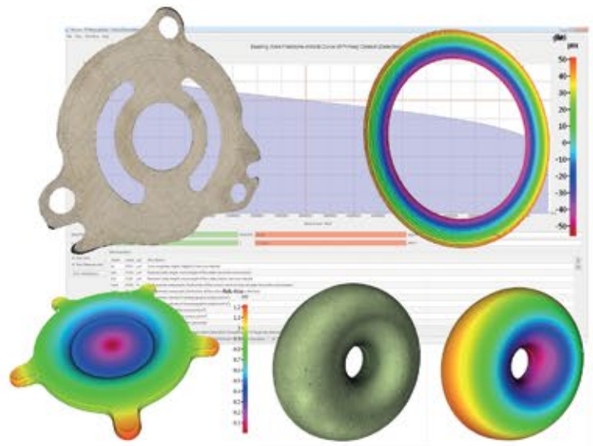


Automotive Industry

- 3D measurement of fuel injection nozzles, measurement of valves, connecting rods and envelopes
- High-resolution measurement of valve seat roundness: deviations in roundness are capably measured even in the 1-2 micron tolerance range.
- Automatic cam inspection: Evaluation of ridges and distance between laser lines
- Failure analysis and development of materials for engine and transmission components (e.g. corrosion, analysis of breakdown, measurement of spinning in angular gearbox, gear damage, 3D measurement of multi-plate clutches and synchronizers)
- Robot-based measurement of engine blocks
- Quality assurance on pumping systems (based on oil and water)
- Material optimization during the development of drive and axle systems
- Quality assurance of car body and steel surfaces
- Comparison of differently honed surfaces by determination of functional volume parameters
- Quality assurance of sealing systems, contour measurement of synchronizer rings
- Optimization of optical and haptic characteristics of car seats and dashboards

"With Alicona we know if a component is okay and if it lies within specified tolerances and a wide measuring range makes each of our components measurable."

Brett Manwill, *Reliability/Design Engineer, Roush Yates Engines*

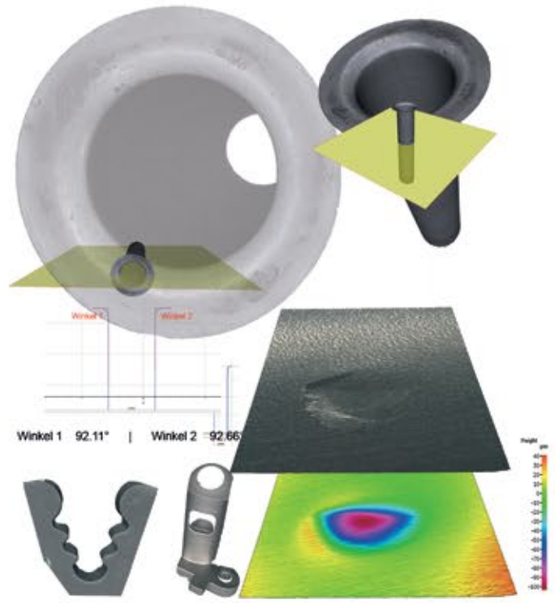


Aerospace

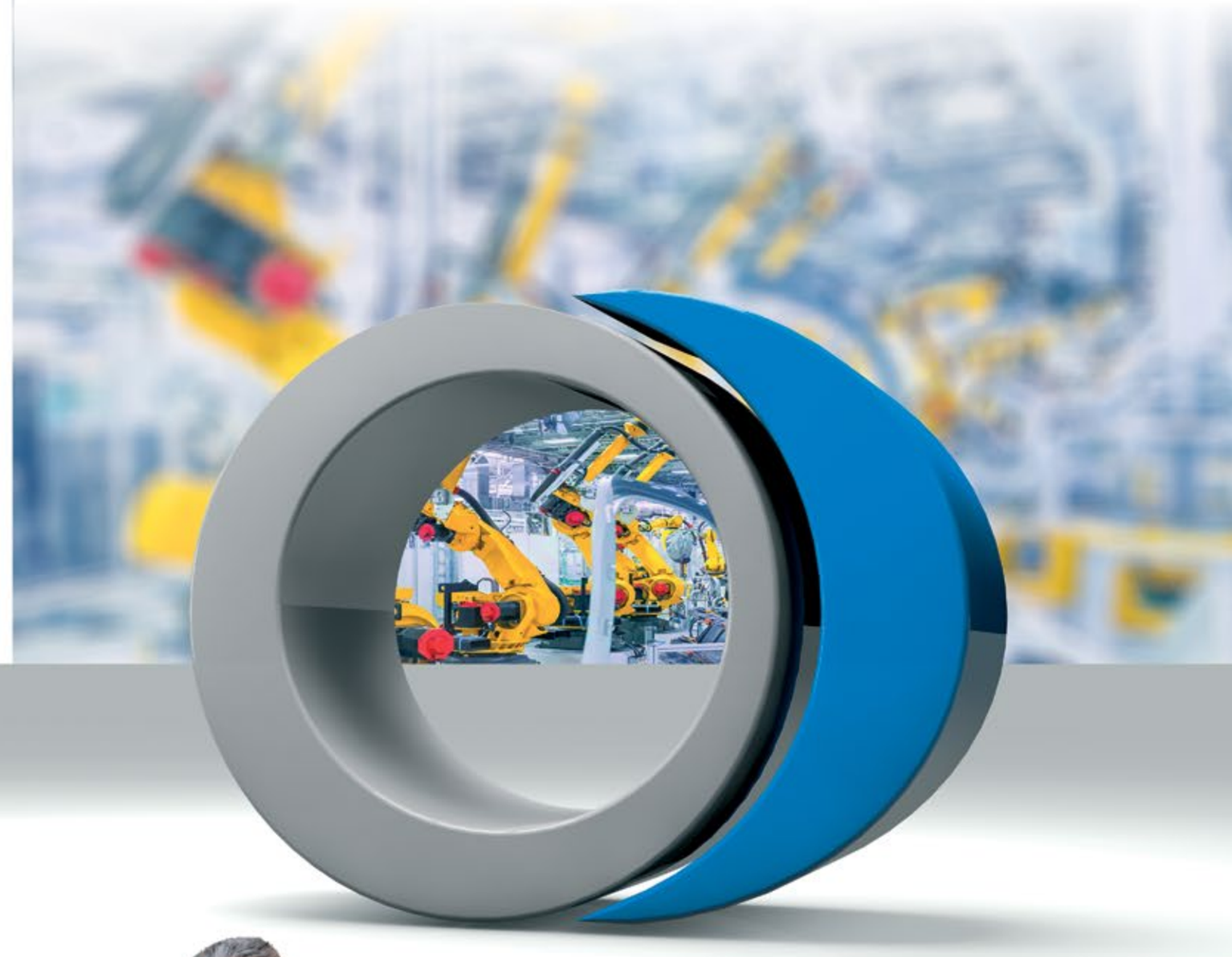
- Automated measurement of cooling holes, edge measurement of turbine blades, verification of edge preparation at the blade root and air foil, roughness measurement for optimization of coating processes
- Measurement and quantification of local surface defects
- Optimization of milling and cutting processes of hard-to-machine materials, such as titanium, composites and heat-resistant alloys.
- Edge measurement and geometric verification of turbine disc fir-tree roots
- Incoming goods inspection and failure analysis
- Testing, materials research and process optimization
- Quality assurance of various materials and geometries, e.g. thread, bearing parts, engine and transmission components, sealing, shafts etc.

"Alicona has paid off within approximately one year as a result of its high flexibility."

Gregor Heichler, *Non Destructive Materials Testing, Airbus*



Smart Manufacturing



"Here at KLEINER, automated quality-assured manufacturing processes are a top priority. Since conventional measuring methods can´t provide the required precision anymore, we invested in an automated manufacturing cell with integrated Alicona measurement technology and a tactile coordinate measurement device. This allows us to meet our customers´ needs and manufacture products of the highest quality quickly and efficiently. Now, and in the future."

Christian Hamann,
Business Unit Manager I Tool Engineering
KLEINER GmbH

KLEINER
Stamping technique

Smart Manufacturing

When measurement technology becomes the smart eye for production

Today's production managers require greater flexibility for small batch size production and tight tolerances. With our solutions for Smart Manufacturing, we demonstrate how Alicona metrology contributes towards profit.

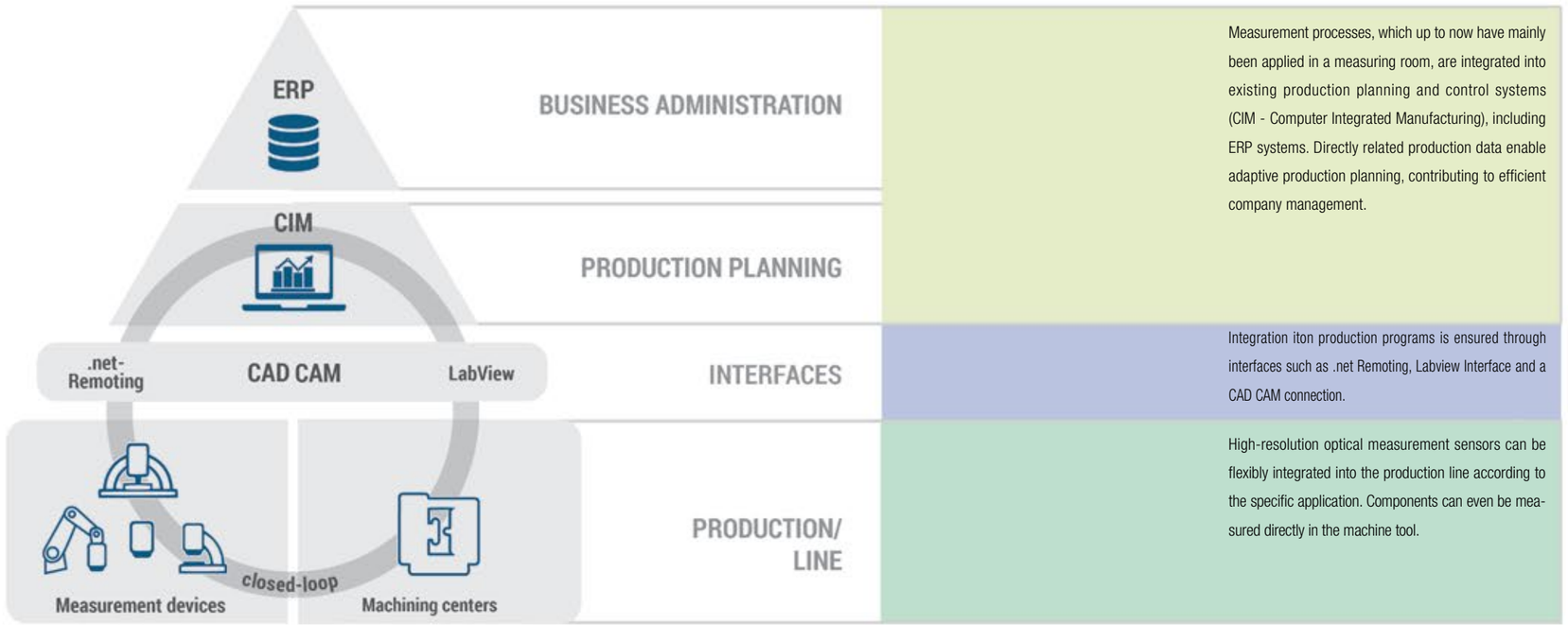
On many production lines, the use of measurement technology for quality assurance is still realized off-line. Inspection equipment is often located at the end of a production chain and the quality of a component is only determined when it has already been manufactured. In the worst case, the component fails to meet the specified tolerances, making it necessary to move through all phases of the production cycle again. As a consequence, measurement technology is often perceived as an expensive, time consuming exercise with no added value. Smart Manufacturing moves quality assurance out from this unloved shadow behind the scenes into a new role, center stage. As an integral part of the production chain, it actively engages in manufacturing operations and corrects production steps when a single component does not meet the correct tolerances. As a result, faulty components are no longer produced; first parts are good parts.

Concept: 3D measurement technology as a smart eye

The use of measurement technology as an integral part of manufacturing is based on optimized communication and networking of all interfaces. Production systems, machines, and measurement technology form a closed loop in constant communication, which makes it possible to produce the first part directly as a good part. The integrated measurement technology is able to verify dimensions, tolerances, and surface quality even at a very early stage of production. If the measuring sensor detects that a component is faulty, this information is fed into the production circuit, which adapts accordingly. Measurement technology becomes the smart eye of production.

In order to implement Smart Manufacturing as an advanced production strategy, companies need fully automated measuring systems that can be used by any operator without prior knowledge of measurement technology. In addition, complex components with tight tolerances require optical, high-resolution measurement sensors that are compatible with production and provide traceable and repeatable measurements.

Alicona´s Focus-Variation offers the ideal platform for using optical 3D measurement technology in production, as it is combined with areal-based high-resolution 3D measurement sensors that can be flexibly integrated. All involved systems are digitized and linked using intelligent interface technology and the provided measurement solutions can be individually customized. This gives manufacturers real-time data on production processes, allowing them to intervene at an early stage. As a consequence, smaller batch quantities with closer tolerances can be produced to a higher level of quality and precision.



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Implementation: Measuring, networking, and individualization

In order for Smart Manufacturing to work effectively, measurement sensors must be integrated into the production line. The metrology equipment must be both capable of networking with existing production systems and being expanded by the manufacturer, if necessary.

Integrating optical measurement sensors into production

Depending on the application, Alicona sensors can be integrated into production in a variety of ways. These are the most common ways of implementing "Smart Manufacturing":

» The use of a standard measuring system combined with the "Automation Manager" interface. Measurement series are configured by an administrator in advance, and then started by the operator in production by pushing a button.

» Using collaborative systems, "Cobots". The measuring sensor is mounted onto a mobile robot platform and can be positioned as needed, even for the measurement of components in the machine. The Cobot's safety concept is built around the physical interaction between humans and robots, and makes conventional enclosures for robots obsolete. Collaborative systems respond to human movements by means of appropriate sensor technology and switch off automatically if there is a risk of injury.

» Integration of the measuring sensor into a machine tool for autonomously controlled production. The sensor communicates deviations in workpieces directly to the machine and the machine parameters are adjusted automatically. Since 2014, Alicona has been offering this type of production as "Closed Loop Manufacturing", in collaboration with US partner EDM Department Inc., a specialist in micro and precision production. Integration of a high-resolution optical 3D sensor in a sinker EDM allows the machine accuracy to be increased by a factor of four through autonomous control and optimization.

Digitization and networking between production systems, machines, and measurement technology

The first step in applying Smart Manufacturing is integrating high-resolution optical measurement sensors. It is then necessary to ensure communication and networking between all the data and systems within the production chain. As a result, the measuring technology moves from a decoupled measuring room into the center of production, where complex measurements are executed quickly and easily. Measurement processes, which up to now have mainly been applied in a measuring room, are integrated into existing production planning and control systems (CIM - Computer Integrated Manufacturing), including ERP systems. Integration into the corresponding production programs is ensured through interfaces such as .net Remoting, Labview Interface, and a CAD CAM connection. All systems involved interact in a closed loop, making it possible to intervene in production at any time. Production measurement data enable manufacturers to plan and control production on a flexible basis, contributing to efficient company management.

The range of products offered by Alicona covers the entire spectrum: As a provider of high-resolution optical 3D measurement technology, we integrate measurement sensors into the production line and provide corresponding interfaces, including a CAD-CAM interface, for connecting to existing production programs. We collaborate with EDM Department Inc., making use of their expertise in micro and precision manufacturing and the acquired measurement data to also offer extended implementation of an integrated Smart Manufacturing production strategy. This allows production managers to achieve autonomous optimization of production and more efficient management of the company.

Measuring systems matched to user requirements

Alicona's high-resolution optical 3D measuring systems can be extended by the user to meet specific requirements. This allows the manufacturer to adapt the measuring device to the individual production process and extend existing functionality. Customer plug-ins facilitate easy extended programming ("scripting") or the implementation of specific, proprietary software programs and libraries. This allows manufacturers to integrate individual parameters and evaluation algorithms into Alicona standard products. That way, they can continue to develop Alicona systems to permanently extend and optimize quality assurance and expertise specific to their company.

Measurement Automation

The automation interface AutomationManager enables repeatable measurements without any prior metrology-knowledge being required.

What has been standard in the tool industry with the EdgeMaster series for a long time already, now applies for all cross-sector optical Alicona measurement systems for the high-resolution measurement of roughness and form. The automation software "AutomationManager" allows for fully automated measurement of complex component geometry in production. Measurement devices can be effectively operated without any prior knowledge of metrology being required.

The AutomationManager is a software platform that makes the automated and user-independent measurement and evaluation of micro-precision components or micro-structured surfaces on large components possible. The process is based on the interplay between an administrator, who defines the measurement program, and operators in the production area. The operator starts the pre-programmed measurements at the touch of a button, the selection of the components to be measured is done by means of a drop-down menu or barcode scanner. The measurement and evaluation of form and roughness parameters runs automatically, the worker has no influence on the measurement result.

An administrator who configures the measurement series off-line, will be guided through three phases of the measurement process. The first phase is to determine the measurement areas on one reference component that can be both a real component, as well as the corresponding CAD data set.

CAD CAM connection

A CAD CAM connection makes it possible to define the measurement points, measurement direction etc. directly in the CAD file. Tilt angle, travel direction in XYZ, as well as rotation angle are automatically calculated and synchronized with the AutomationManager. A simulation makes it possible to create a preview of the measurement process to be carried out, and so ensures a safe and secure measurement planning. The virtual operation of the Alicona measurement systems comprises the entire handling, from the positioning of a component through to the determination of the measurement area in 3D. This allows manufacturers to integrate the measurement technology already into the design phase, which is a significant contribution to the implementation of 3D metrology within the entire production chain.

Following the definition of the measurement areas, it is specified which parameters are to be evaluated. The administrator defines a number of profile based (Ra, Rq, Rz) and areal roughness parameters (Sa, Sq, Sz) to evaluate both dimensional accuracy and surface state of components. Characteristics such as dimensions, distances, angles, concentricity, flatness, as well as deviations from form and position tolerance can be evaluated.

In the final step, the administrator configures the measurement report according to individual requirements and saves the target values wanted, which include OK/not OK determination.

It is then the worker's turn. It is usually an operator without any knowledge of measurement technology in the production area, who simply presses a button in order to start the pre-set measurement programs. Measurement positions are automatically controlled and the pre-programmed parameters are measured automatically, without any influence from the user, enabling repeatable measurements. At the end, the worker receives a measurement report containing OK/not OK data.

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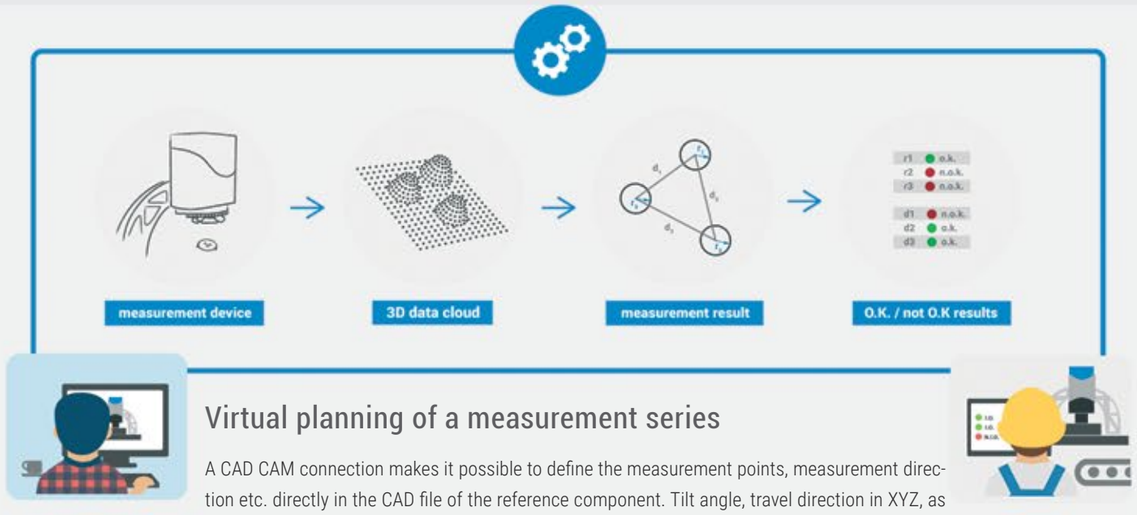
"Full measurement automation, as it is provided by Alicona´s Automation Manager, enables us to meet our customers´ requirements for repeatable measurements of components with tightest tolerances and highest manufacturing accuracy."

KENDRION
WE MAGNETISE THE WORLD

Stefan Steimle,
Head of Quality Management,
Kendrion (Germany)



Virtual planning of a measurement series

A CAD CAM connection makes it possible to define the measurement points, measurement direction etc. directly in the CAD file of the reference component. Tilt angle, travel direction in XYZ, as well as rotation angle are automatically calculated and synchronized with the AutomationManager. A simulation makes it possible to create a preview of the measurement process to be carried out, and so ensures a safe and secure measurement planning.

If the AutomationManager is used in combination with a rotation unit (here InfiniteFocusG5 with the Advanced Real3D Rotation Unit), an integrated zero-point clamping system ensures that each component is clamped in a defined position that enables accurate and repeatable measuring.

Man, robots, and 3D metrology

Cobots make modern production strategies possible

Collaborative robots and optical metrology come together to create collaborative systems that enable flexible quality assurance in production.

Alicona Cobots combine a collaborative 6-axis robot and a robust optical 3D measurement sensor to deliver traceable and repeatable high-resolution measurements, even in production. They require no prior knowledge of metrology and make handling, programming, and executing measurement series easy. This is made possible by intuitive hand-guided controls for the teach-in of measurement series, automatic measurement evaluation, and a no-enclosures safety concept. As a result, Cobots are ideal for verifying the surface state and dimensional accuracy of work pieces in existing production environments.

The following real-world examples demonstrate the advantages and capabilities of two new Alicona Cobots. The DiscCobot is used to automatically verify the edges of turbine discs and the highly flexible ToolCobot allows users to measure large tools directly in the machine tool.

DiscCobot

DiscCobot: Avoiding sharp edges on turbine disks

The DiscCobot is used for the quality assurance of turbine discs weighing up to 120 kg. In particular, the Cobot is applied in the standardized evaluation of edge breaks. By verifying minimal radii, it prevents sharp edges that can, in the worst case, compromise aircraft safety. Operating and programming the Cobot is easy and intuitive. The robot arm, with its attached measuring sensor, is easily and conveniently manipulated by the operator to reach the desired surface position. Two handles with an integrated joystick are mounted on the sensor, making the robot arm easy to move. A smartphone app displays the live view for manual, precise positioning and measurement. Using connected automation software, any series of measurements can be defined at several positions, which the operator then starts with the press of a button. Control and measurement are fully automated, and upon completion the worker receives a measurement report with OK or Not OK details.

Let´s cobot your application!

Would you like to know more about collaborative systems and flexible quality assurance with Alicona Cobots? Simply get in touch with us.

We can design a Cobot that matches your needs. Our experts are looking forward to hearing from you.

metrology@alicona.com

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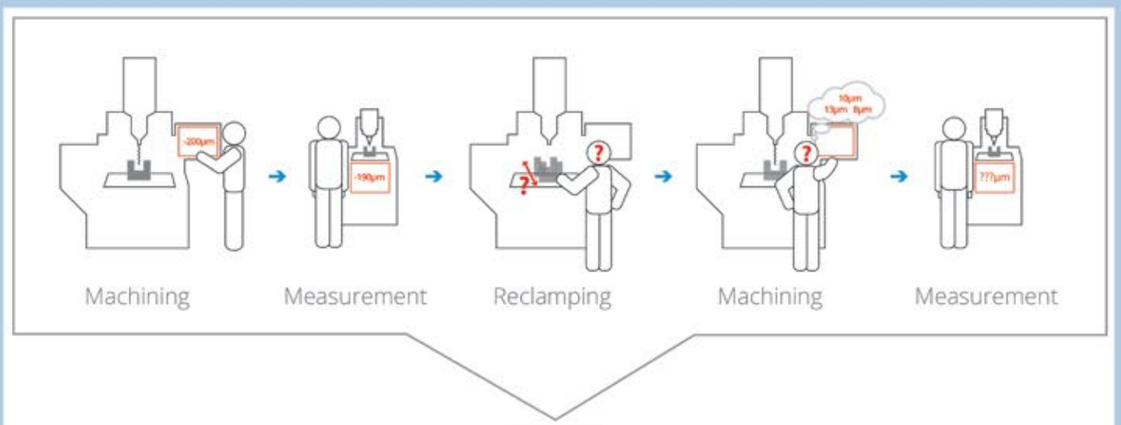
ToolCobot: Measuring tools directly in the tool machine

Designed for measuring large tools, the ToolCobot is an innovative addition to Alicona's range of optical edge measuring devices. It is used, in the quality assurance of drills, millers etc. with shanks of up to 1 m in length. In addition, hobs and broaching tools are measured. The ToolCobot features an HSK interface for easy tool fitting and can be adjusted vertically and horizontally thanks to its flexible axes, ensuring ergonomic operation. The system is also mounted on wheels for added mobility, meaning the Cobot can easily be moved to wherever it is needed. No more re-clamping components or work pieces from the tool machine to measure them—the ToolCobot inspects them directly in the machine. This way, defects and tolerance deviations are detected at an early stage rather than at the end of the production process, preventing faulty components from being produced.

ToolCobot

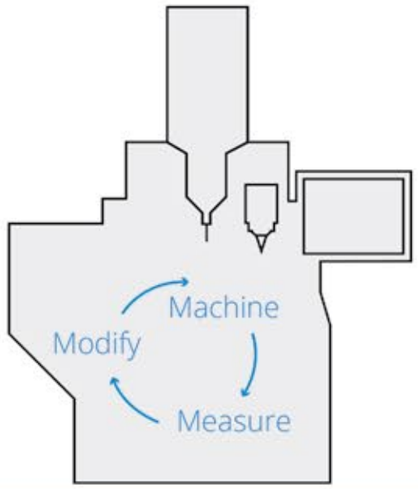
ClosedLoopManufacturing

High precision EDM machine with integrated optical 3D measurement sensor by Alicona



Five in One.

The closed-loop technology is a revolution: An all-in-one manufacturing method that puts every necessary process step inside one machine tool. It delivers outstanding performance based on the integration of expert knowledge, machining and metrology.



Closed-Loop Manufacturing.

With optical metrology workpieces are continuously measured in-situ during production. Deviations from target values instantly affect the machining parameters. This closed loop isn't just designed to automate quality assurance, it also brings machining accuracy to a totally new level.

Machine Sales.

Alicona Manufacturing is your one stop shopping resource for Closed-Loop Manufacturing. We offer a ready to go, self guided sinker EDM machine. Our experience is embedded in the accompanying smart manufacturing software. You benefit from our competence in installation, training as well as manufacturing consulting service together with the machine itself.

Precision Parts Manufacturing.

Alicona Manufacturing is built on years of expertise in precision and micro parts manufacturing. Our in-depth knowledge is showcased at our state-of-the-art automated manufacturing facility wherein wire and sinker edm, milling and laser machining technologies are ready to produce your parts, no matter what the quantity. You benefit from an unbeaten price performance ratio made possible by Closed-Loop Manufacturing.

Consulting Services.

Alicona Manufacturing is ready to support your aims towards Closed-Loop Manufacturing in your facility. We offer any level of consulting for precision and micro manufacturing automation. From part design and manufacturing technology selection to final production quality control, we are happy to share our expertise. You benefit from a tremendously shortened realization time of your transition towards automated manufacturing.

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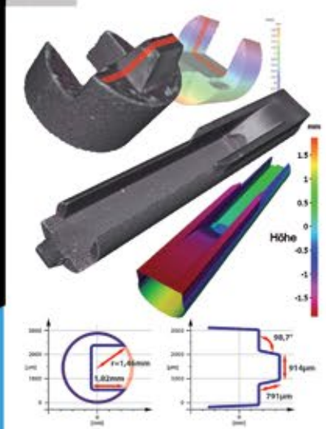
Alicona Manufacturing.

Alicona Manufacturing is a joint venture formed through the collaboration of Alicona, global supplier of optical 3D surface measurement solutions, and EDM Department Inc., specialist in micro and precision manufacturing, located in Bartlett, IL.

The venture combines the technological expertise of Alicona Imaging GmbH and the production know-how of EDM Department to further the development and creation of advanced high resolution optical measurement solutions for manufacturing.

With Closed-Loop Manufacturing the joint venture offers a state-of-the-art, self-optimizing machining method for the production of precision components in the µm and sub-µm range. The intent of this cooperation is to formulate and develop solutions that will meet the ever rising demands of the manufacturing industry by increasing productivity and efficiency while enabling greater profitability.

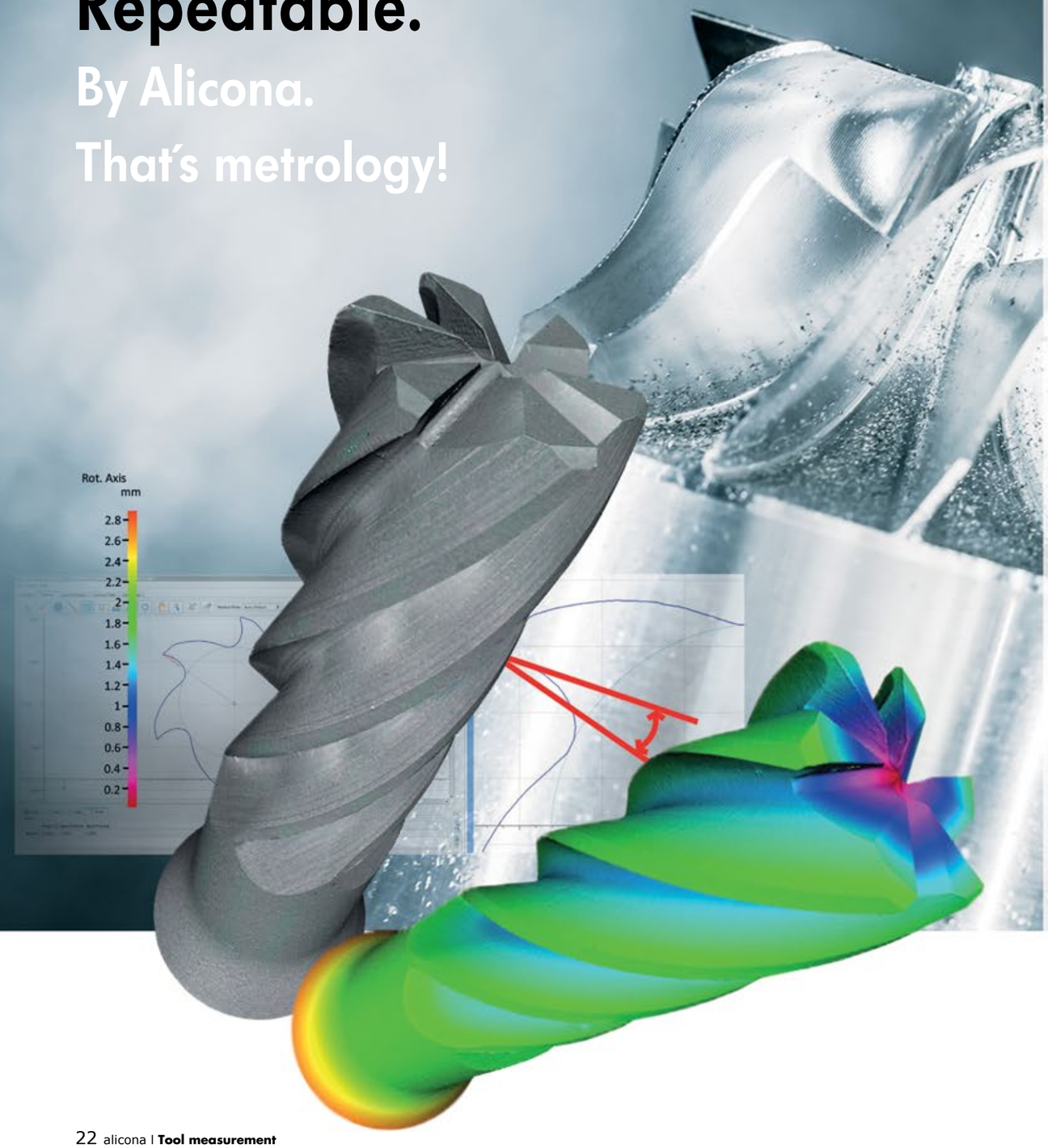
Full line of closed-loop machining applications include products, services and consulting expertise.



Tool measurement. Robust. Repeatable.

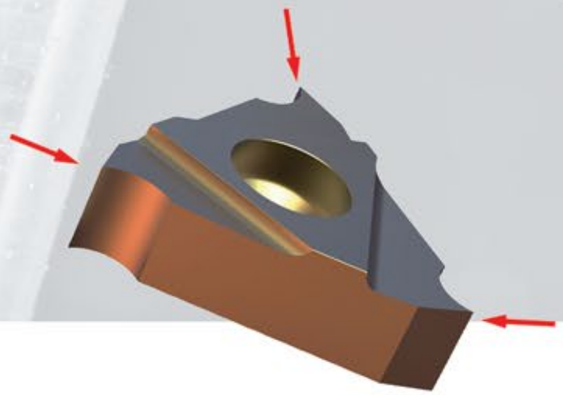
By Alicona.

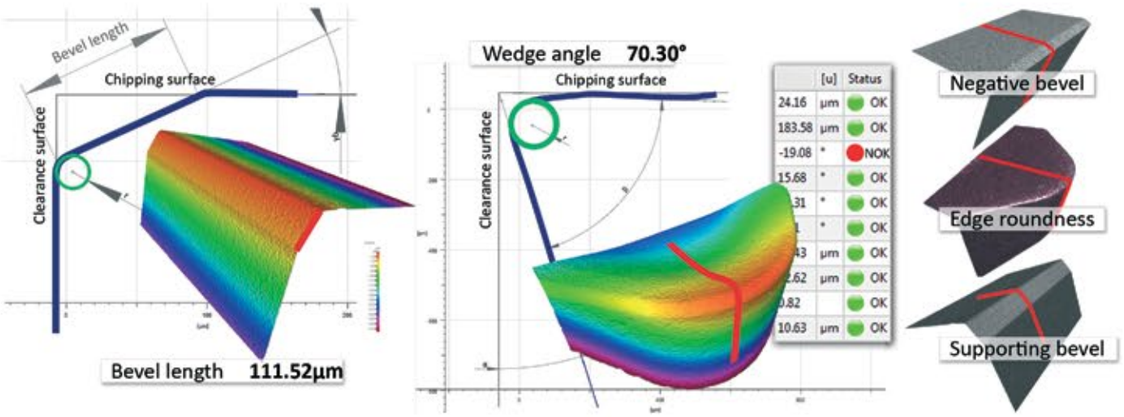
That´s metrology!



Tool measurement

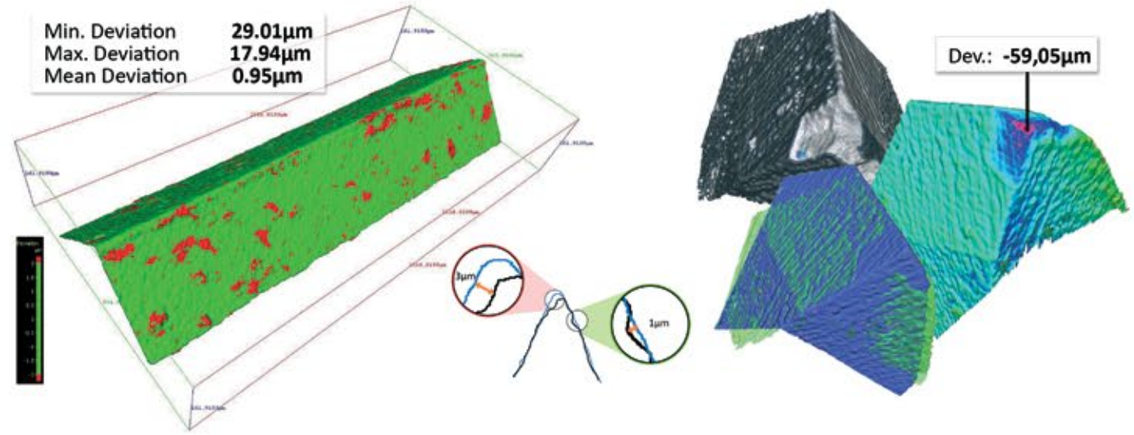
Worldwide leading tool manufacturers use Alicona for quality assurance of cutting edges and geometries within their production. The broad range of Alicona technologies is comprised of fully automatic measurement solutions for production and comprehensive analysis modules, including visualization for a laboratory. All measurements, regardless of the application site, are characterized by high resolution, traceability and repeatability. By means of elliptical measurement, Alicona users get precise and actual results of their tool kit edge's shape. In addition, options such as measurement of roughness, edge break and ridges offer a wide range of opportunities for numerical evaluation of edge quality.





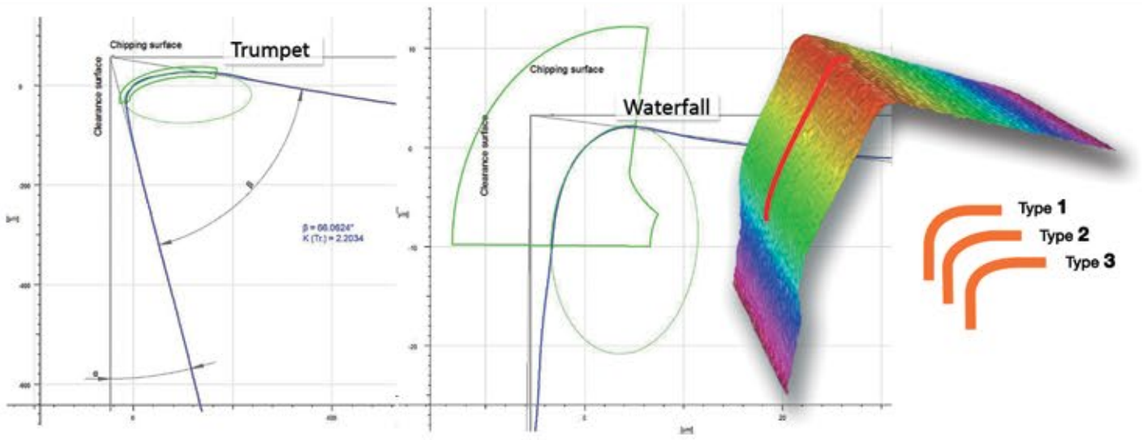
MEASUREMENT OF RADIUS AND FORM

With the use of radius-fit, radius, clearance angle (α), wedge angle (β), rake/chipping angle (γ), edge symmetry (K) as well as negative and positive bevel lengths are measured. Measurements include projected bevel length, true bevel length and bevel angles.



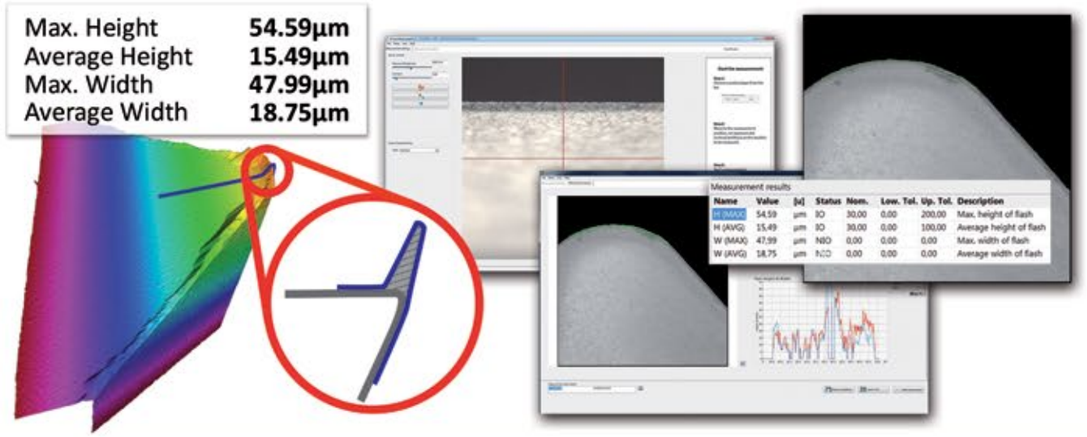
FORM DEVIATION WITH DIFFERENCE MEASUREMENT

3D measurements are automatically compared to an imported 3D data set or reference geometry. Measurable parameters include minimum, maximum and mean deviation from the reference surface. Also, form deviations are clearly visible by advanced color visualization.



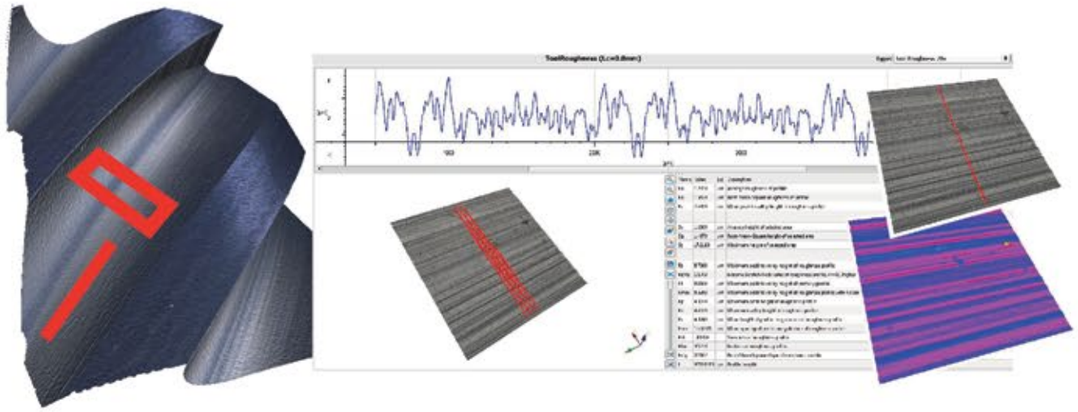
MEASUREMENT OF "TRUE" CONTOUR THROUGH ELLIPTIC FIT

Inserts with both waterfall and trumpet shapes are measured. A fit of elliptic shapes into the edge region describes the shape by two radial parameters. The edge can also be compared to user-defined basket arch files of arbitrary shape.



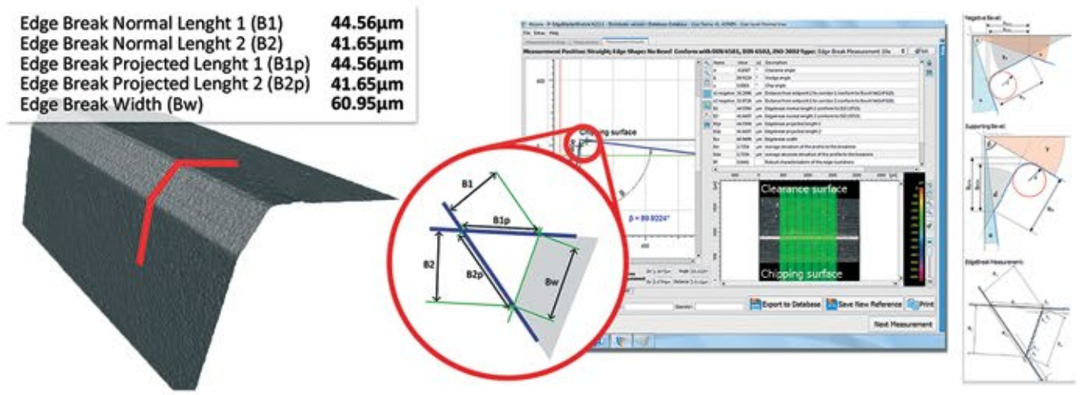
FLASH MEASUREMENT

Users measure width and height of an insert´s burr (or flash) which can occur during molding. The numerical verification of the burr enables the early identification of potential wear of molding tools during the manufacturing of inserts.



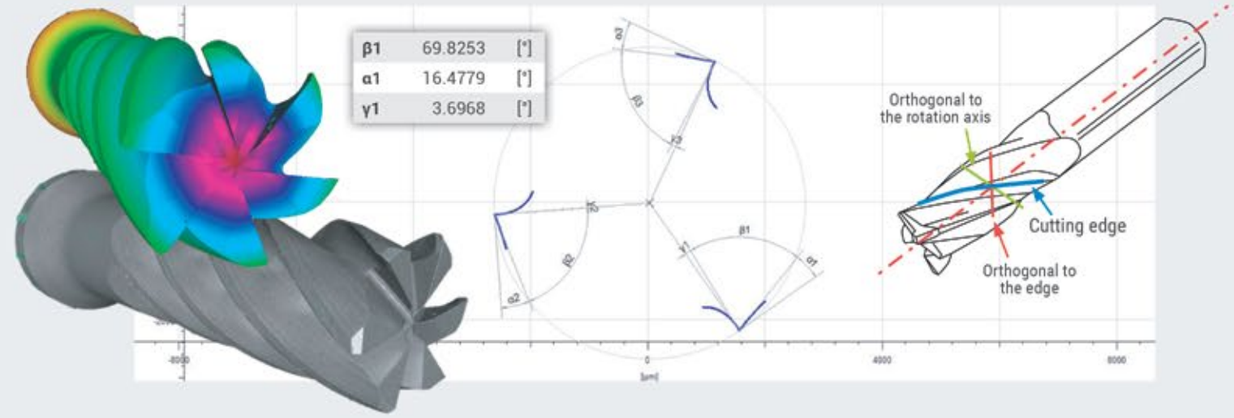
TOOL ROUGHNESS MEASUREMENT

In addition to chipping along the edge, users are also able to measure tool roughness with both profile and areal based parameters.



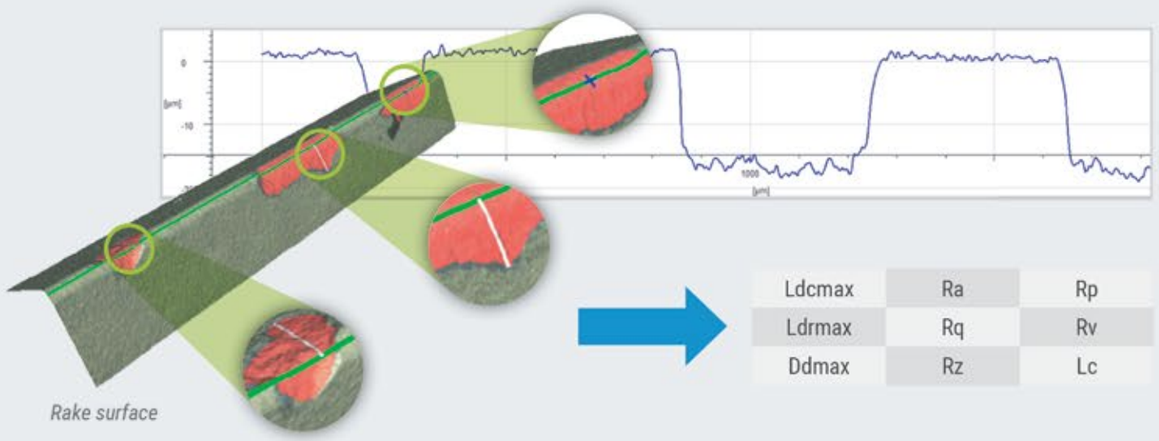
CHAMFER MEASUREMENT

Measurable parameters of an edge break include chamfer width, various angles, width of edge break, normal distances and other ISO 1375 conform parameters.



ANGLE MEASUREMENT

Users measure clearance angle, wedge angle and rake angle of inserts, drills, end mills and other round tools. Measurements are performed in respect to the tool axis.



CHIPPING MEASUREMENT

Users benefit from fully automatic chipping measurement. Parameters include total depth, length and volume to verify edge quality of inserts and round tools. Edge defects are visualized in 3D. Also, high resolution measurement of ISO 4287 conforming parameters (Ra, Rq, Rz, Rp, Rv….) is provided.

MultiEdgeMeasurement

How to measure multiple edges in only one measurement cycle

MultiEdgeMeasurement offers fully automatic measurement of user defined parameters at various tool positions all in a single measurement run.

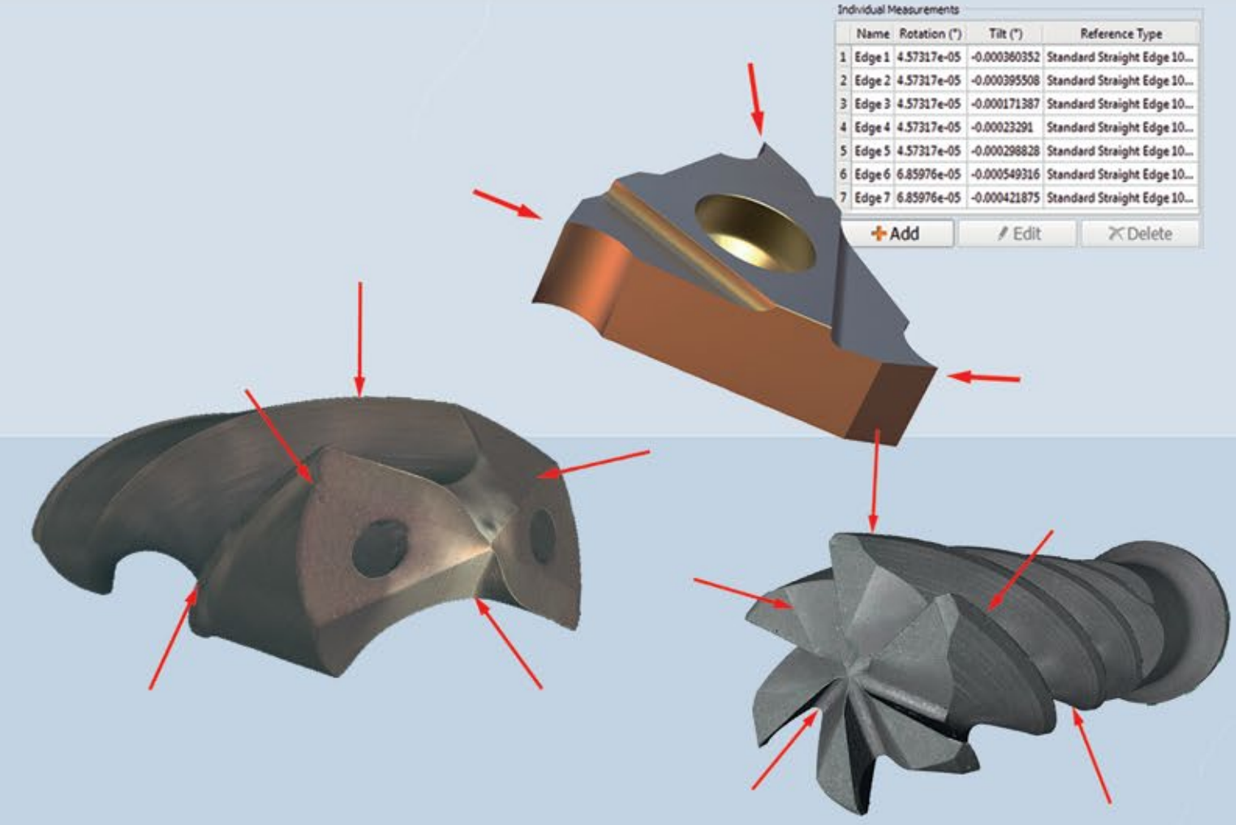
Metrology expertise is not needed to verify the quality of inserts, cutters, drills or other round tools. The administrator just sets necessary parameters and measurement positions in the software and then the sequence can be started and carried out at any time without further user influence.

Upon completion, all results are clearly summarized in a single chart with a traffic light system reporting immediately if the work pieces comply with the tool specifications. For additional details on the individual parameters, users can just click on the result of interest.

This automation decreases the inspection time for both individual tools as well as entre batches. In addition, personnel resources are set free as the measured tools don't require repositioning or modification in the software settings.

Typical application areas are:

- Verify edge geometries through the measurement of various edge positions.
- Automatic inspection of drill, cutting miller or insert
- Rapid quality assurance of an entire batch



AUTOMATIC INSPECTION OF DRILLS, CUTTING MILLER AND INSERTS

Automatic measurement sequence including multiple parameters at different positions on a tool by using a rotation unit.

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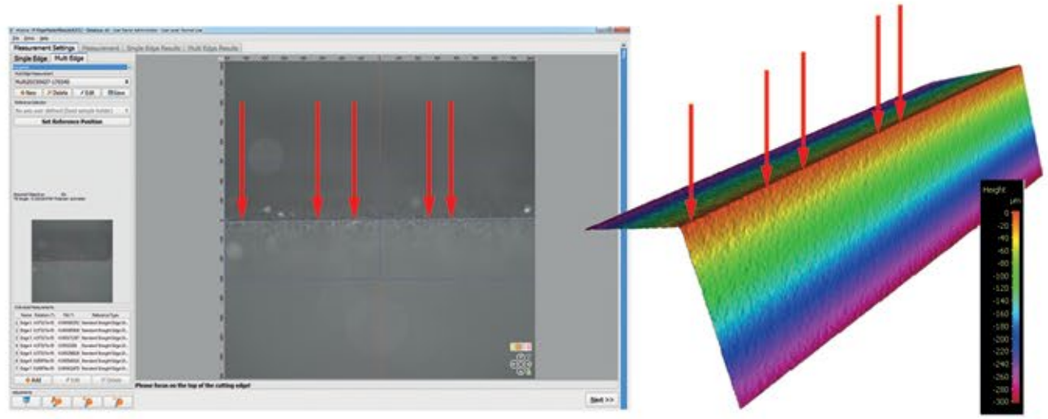
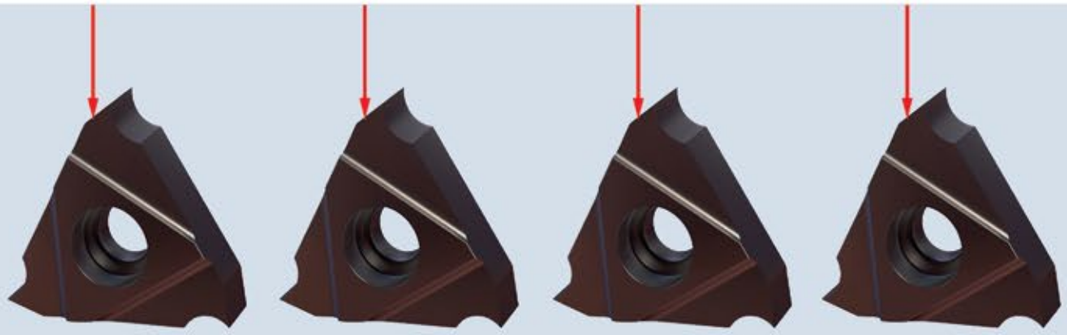


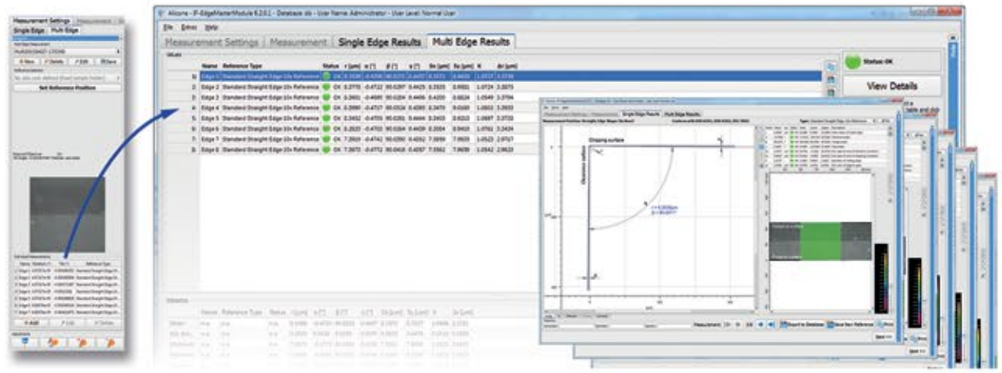
MEASUREMENT OF MULTIPLE EDGE POSITIONS

The user defines the measurement parameters for various tool positions. All parameters then are measured automatically and users receive results for each selected position.



MEASUREMENT OF SELECTED PARAMETERS ON MULTIPLE TOOLS

Users can measure a number of parameters across multiple tools. This enables, for example, quality assurance of an entire batch.



RESULTS SUMMARY FOR EASY VERIFICATION

All measuring data is clearly summarized in one chart. A traffic light system reports immediately if a work piece is within tolerances with additional details available as well.

This drill shows a high resolution 3D measurement, not a picture or photo.

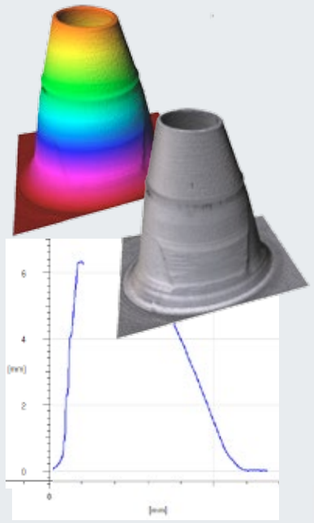
Alicona.
That´s Focus-Variation!

Form & roughness in one system.

Alicona measurement systems are based on the technology of Focus-Variation and combine the functionalities of a surface roughness measurement device and a form measurement system.

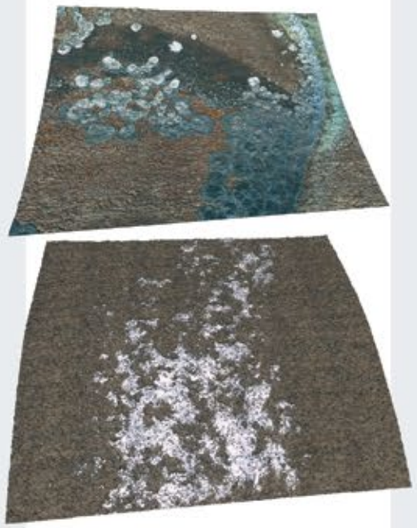
Each Alicona measurement instrument is a

- » surface measurement device
- » surface roughness measurement system
- » 3D measurement system for geometrical tolerancing
- » micro coordinate measurement system



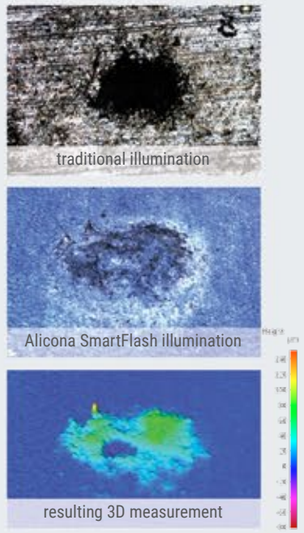
Steep flanks

Light coming from different directions is used to positively influence a measurement. The measurement of the maximum flank angle is not restricted by the numerical aperture of an objective. Depending on the surface users measure surfaces with slope angles up to 87°.



True color information

Alicona´s Focus-Variation provides color information of surfaces in addition to depth information. Users receive a color image with full depth of field which is registered to the 3D points.



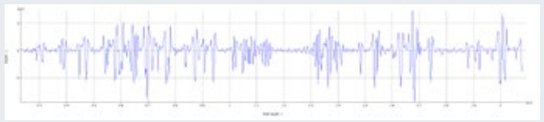
Varying surface reflections

SmartFlash allows high resolution measurements of materials with varying surface characteristics or reflectivity. Modulated light provides optimal illumination throughout the whole measurement area. Users measure glossy, ground, rough, reflective and diffuse components.

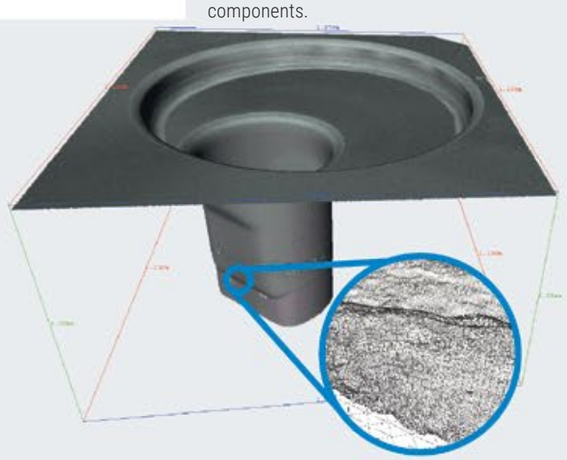
roughness profile, Alicona measurement at vibrations

Ra = 0,048 µm

roughness profile, conventional technology at vibrations



Ra = 0,466 µm



Robust against vibrations

For each measurement point Alicona systems process information not only from image points directly in the focal plane but also from areas out of focus. As focus information is utilized over a larger scan depth, the influence of vibrations on the measurement is reduced to a minimum. Users receive high resolution, traceable, and repeatable measurements even in environments with considerable vibrations.

Detailed measurements

Up to 500 million measurement points ensure a meticulously detailed measurement. Measurements with tolerances in the µm and sub-µm range along with large working distance are achievable. The high measurement point density of Focus-Variation enables operators to gain a consistently high lateral and vertical resolution even across high measurement volumes. Traceable measurement of small and often hard to access radii, angles, and roughness are also possible.

One Sensor. One Technology. Multiple Measurements.

Form and roughness in one system

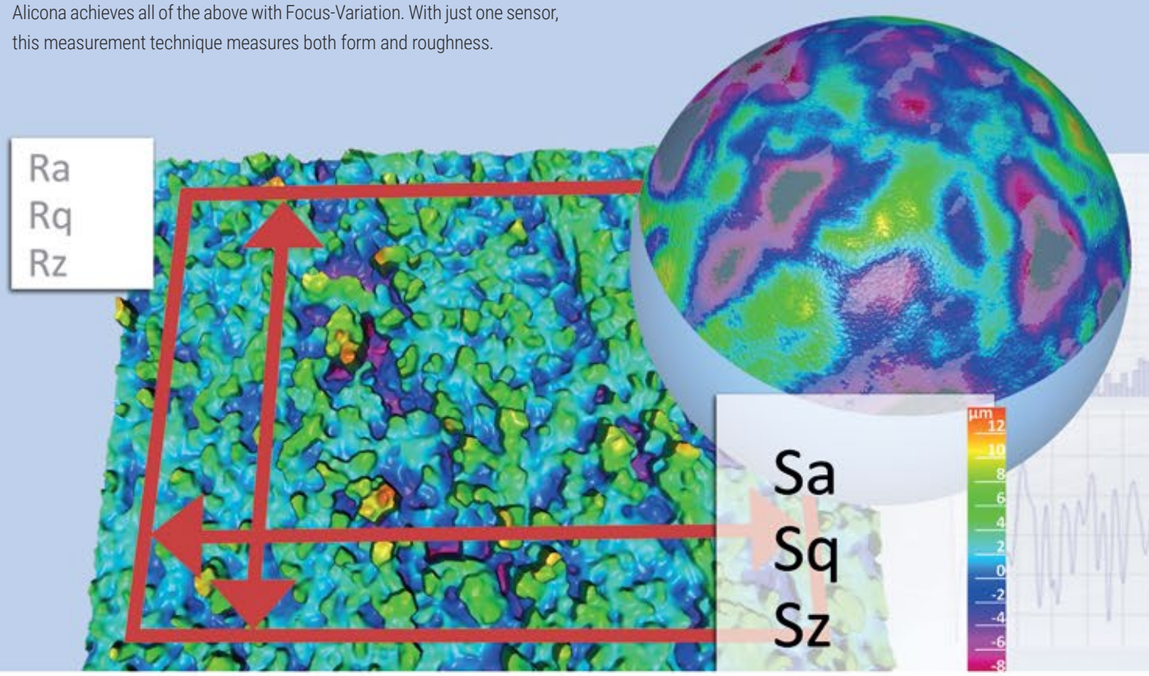
The complexity of a component determines how 3D metrology can be applied. Either a single measurement is performed or multiple individual measurements that are then merged into a full 3D data set. To ensure users receive repeatable and traceable high-resolution measurement results, several requirements need to be met.

» **The technology being used must be able to capture steep flanks, offer intelligent illumination, and provide registered color information of surfaces in addition to depth information.**

» **When merging multiple measurements, it is critical that a large number of measurement points can be processed and a highly accurate axis system is used. This ensures that tolerances and roughness at the µm and sub-µm level are measured in high resolution.**

» **Regardless of a component's geometrical complexity the influence of vibrations on the measurement result must be reduced to a minimum.**

Alicona achieves all of the above with Focus-Variation. With just one sensor, this measurement technique measures both form and roughness.



Picture © SKB and Posiva Oy
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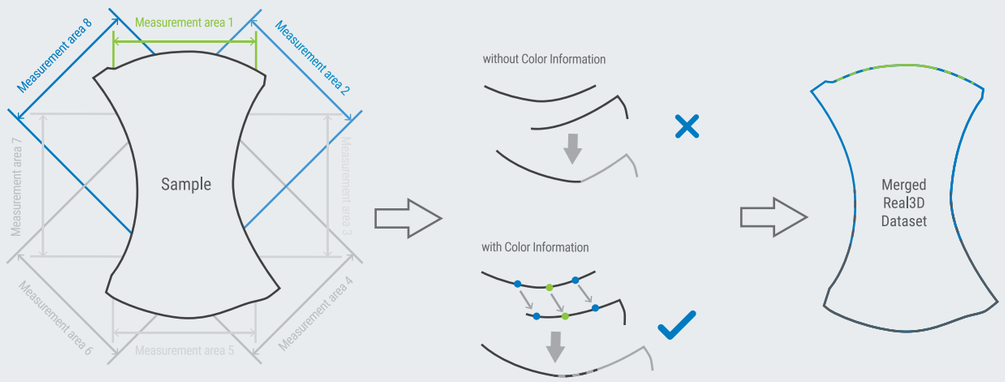
Full form measurement

Using Real3D, users measure surfaces from numerous perspectives. Single measurements are then automatically merged into a full 3D dataset. High-precision and calibrated rotation and tilt axes ensure automated, repeatable and traceable measurement of form and roughness on the whole measurement object. Users are able to visualize and measure surface features such as diverse flank angles, thread pitch and undercuts.



HOW REAL3D WORKS

The component is measured at various rotation and tilt angles. Based on the registered true color information of each measurement point, the single measurements are transformed into a joint coordinate measurement system. The single overlapping measurements are then precisely merged into a complete 3D data set.

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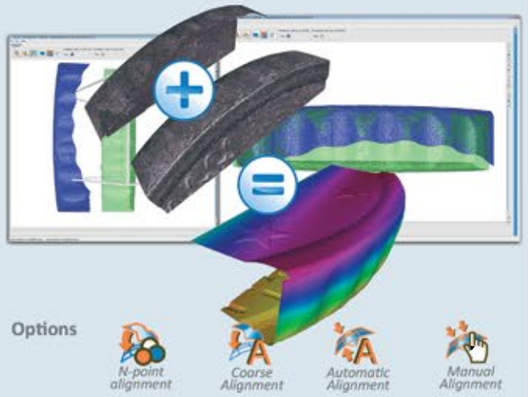
Fusion Measurement

Individual measurements are merged into a full 3D data set

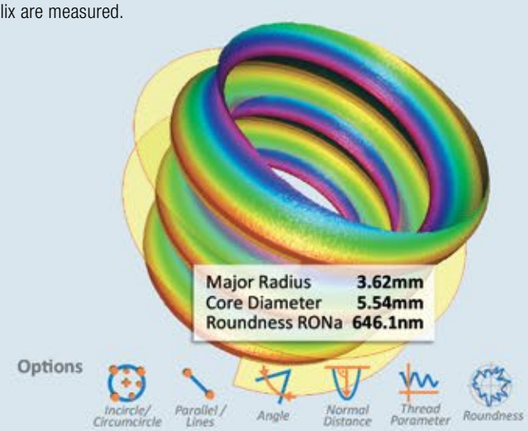
Single measurements from various positions are automatically merged into a 3D data set. The Real3D technology allows the visualization of the component from different angles plus a measurement of contour, difference and form.



Contour Measurement

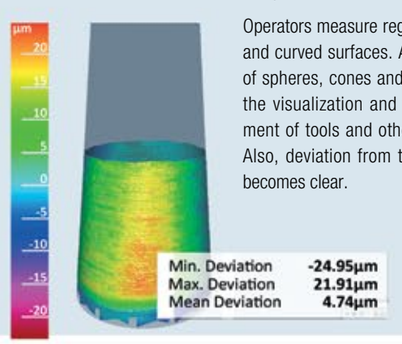
Analysis of even complex profiles

Users measure angles, distances, circles, incircles, circumcircles, thread pitch etc. from every position. In addition, the contour measurement module includes roundness measurement. Even complex profiles of e.g. along a helix are measured.



3D Form Measurement

Measurement of flat and curved components

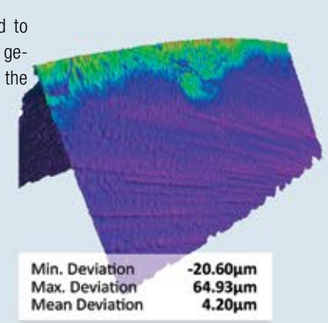


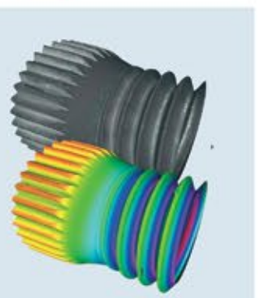
Operators measure regular geometries and curved surfaces. Automatic fitting of spheres, cones and cylinders allow the visualization and form measurement of tools and other components. Also, deviation from target geometry becomes clear.

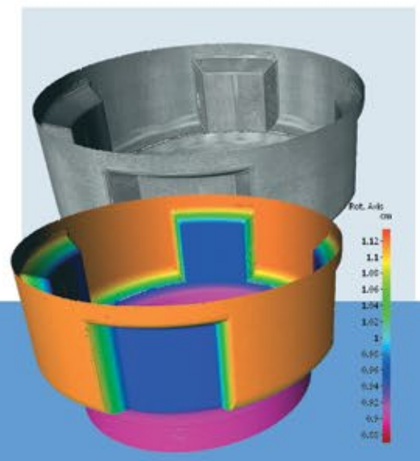
Difference Measurement

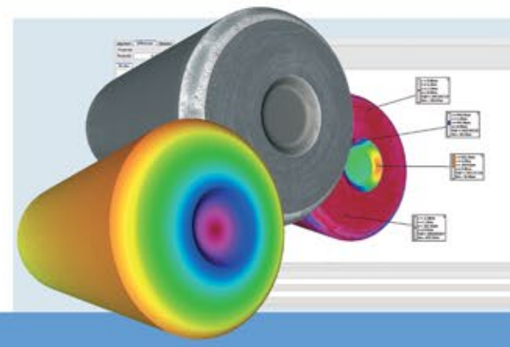
Verification of form deviation

Difference measurement is used to numerically compare two different geometries. A typical application is the measurement of wear before and after use of a cutting tool. Also, users measure form deviations to a CAD-dataset or reference geometry. The module is also used in the field of Reverse Engineering.





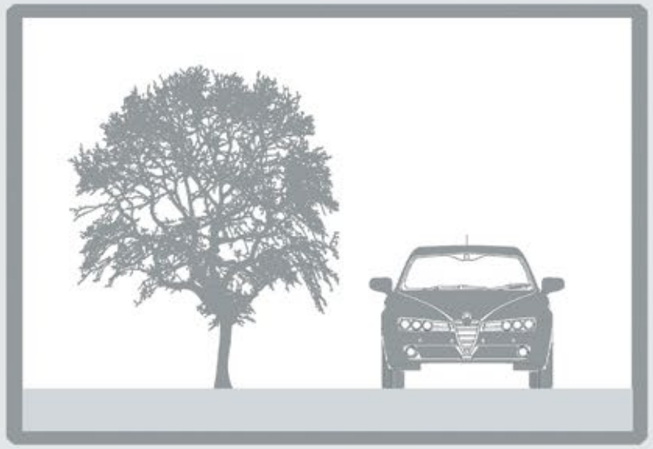




Focus-Variation

The technical principle of Focus-Variation

Focus-Variation [1] combines the small depth of focus of an optical system with vertical scanning to provide topographical and color information from the variation of focus. The main component of the system is a precision optics containing various lens systems that can be equipped with different objectives, allowing measurements with different resolution.



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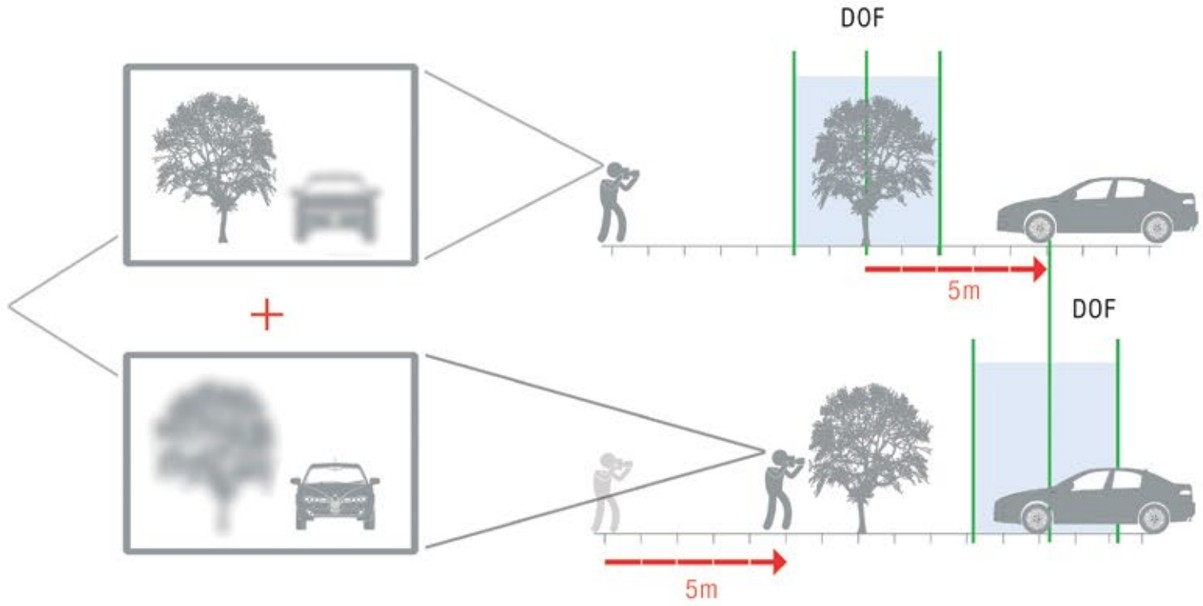


With a beam splitting mirror, light emerging from a white light source is inserted into the optical path of the system and focused onto the specimen via the objective. Depending on the topography of the specimen, the light is reflected into several directions as soon as it hits the specimen via the objective. If the topography shows diffuse reflective properties, the light is reflected equally strong into each direction. In case of specular reflections, the light is scattered mainly into one direction. All rays emerging from the specimen and hitting the objective lens are bundled in the optics and gathered by a light sensitive sensor behind the beam splitting mirror. Due to the small depth of field of the optics only small regions of the object are sharply imaged.

To perform a complete detection of the surface with full depth of field, the precision optic is moved vertically along the optical axis while continuously capturing data from the surface. This means that each region of the object is sharply focused. Algorithms convert the acquired sensor data into 3D information and a true color image with full depth of field. This is achieved by analyzing the variation of focus along the vertical axis.

In contrast to other optical techniques that are limited to coaxial illumination, the max. measurable slope angle is not only dependent on the numerical aperture of the objective. Focus-Variation can be used with a large range of different illumination sources (such as a ring light) which allows the measurement of slope angles exceeding 87°.

Basically, Focus-Variation is applicable to surfaces with a large range of different optical reflectance values. As the optical technique is very flexible in terms of using light, typical limitations such as measuring surfaces with strongly varying reflection properties even within the same field of view can be avoided. Specimen can vary from shiny to diffuse reflecting, from homogeneous to compound material and from smooth to rough surface properties. Focus-Variation overcomes the aspect of limited measurement capabilities in terms of reflectance by a combination of illumination, controlling the sensor parameters and integrated polarization. Modulated illumination means that the illumination intensity is not constant, but varying. The complex variation of the intensity can be generated by a signal generator. Through the constantly changing intensity far more information is gathered from the specimens´ surface.

In addition to the scanned height data, Focus-Variation also delivers a color image with full depth of field which is registered to the 3D points.

This provides an optical color image which eases measurements as far as the identification and localization of measurement fields or distinctive surface features are concerned. The visual correlation between the optical color image of the specimens´ surface and its depth information are often linked to each other and are therefore an essential aspect of meaningful 3D measurement.

Since the described technique relies on analyzing the variation of focus it is only applicable to surfaces where the focus varies sufficiently during the vertical scanning process. Surfaces not fulfilling this requirement such as transparent specimen or components with only a small local roughness are hardly measurable.

Typically, Focus-Variation delivers repeatable measurement results for surfaces with a local Ra of 0.009 µm at a lc of 2 µm. Focus-Variation is used to perform high resolution 3D surface measurement for quality assurance in production as well as research and development activities in the lab. Key applications are surface analysis and characterization in e.g. tool & mold making, precision manufacturing, aerospace, automotive industry, all kinds of materials science, corrosion and tribology, electronics, medical device development. Due to its´ technical specifications the Focus-Variation technique is used for both form and roughness measurements.

[1] ISO 25178-6: Geometrical product specifications (GPS) -- Surface texture: Areal --
Part 6: Classification of methods for measuring surface texture, Draft.

Focus-Variation in Comparison

Accurate measurement solutions with high resolution are a necessity whenever surface qualities and micro geometric features need to be examined. In comparison to alternative optical technologies, Focus-Variation closes the gap between typical 3D coordinate measuring technology and classical surface metrology devices.

Profile projectors

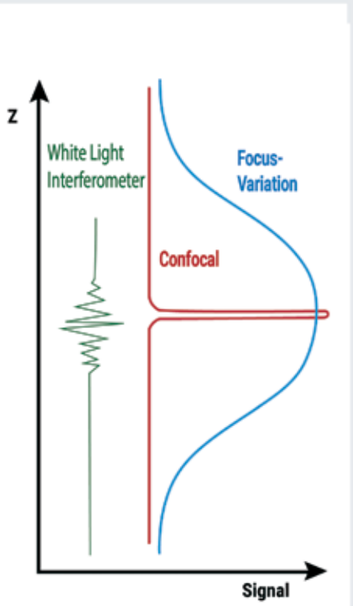
and other image processing systems are the predecessors of present optical measurement systems and are still relevant for understanding optical measurement technology. Profile projectors enlarge the components' surface characteristics and project the image onto a screen. Through pattern matching the image is compared to an appropriate reference.
Advantages are measurements that can be executed within seconds, although the automatic measurement of geometric features is limited to two-dimensional applications only. One main disadvantage is its sensitivity to object alignment. Depending on its orientation, differing measurement results can be obtained.

Structured light

is based on a projector that illuminates the measurement object with several bright and dark stripes and captures it with at least one camera. The topography of the sample distorts the stripe pattern of the projector. The distorted pattern is recorded with a camera and, finally, the topography is calculated via image processing. One advantage of structured light is the high measurement speed when measuring large surfaces. Therefore, the technology is primarily used for the measurement of very large parts (e.g.: bodywork). The technology is of limited suitability for high-resolution sub-µm depth measurements as, for example, with roughness measurements. In addition, the low depth of field and high sensitivity to varying surface characteristics substantially limit the application range.

Confocal measurement

is characterized by its high lateral resolution. Right at the focal point inside the detector an additional aperture is used to block light from above and below the focal plane. Thereby, only light within the focal plane passes through the detector. By detecting the strongest signal depth is measured. Confocal systems are particularly suitable for measurements of very smooth surfaces that can be found on silicon structures or semiconductor geometries. The advantage of high resolution in z is accompanied with increased sensitivity towards vibrations.



White light interferometer (WLI)

use interference effects in order to determine topographical features. One advantage is the high vertical resolution. While rough surfaces are difficult to measure the method is ideally suited for the evaluation of lenses and glass structures.

Focus-Variation

gathers not only depth information but also registered true color information of the surface. Roughnesses of micro and nanostructures are measured both profile and area based. Complex geometries are measured via the Real3D technology from different perspectives which are then merged into a full 3D dataset. By measuring form, dimension, position and roughness in one system, Focus-Variation closes the gap between typical 3D coordinate measuring technology and classical surface metrology.
In contrast to profile projectors not an outline is measured, but the components' 3D surface. While confocal systems and interferometers measure intensity peaks or intensity modulation only in a very narrow band around the focal point of the system, Focus-Variation measures sharpness over a considerably larger region. Therefore, the technology is much more tolerant against vibrations.

While confocal systems and interferometers measure intensity peaks or intensity modulation only in a very narrow band around the focal point of the system, Focus-Variation measures the variation of focus over a 100 times larger region. Therefore, the technology is much more tolerant against vibrations.

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Measurement process capability and accuracy

To assess a measurement's system suitability for a particular application, it is necessary to quantify its measurement process capability and accuracy. Here, the most important concepts and terms in relation to its determination are explained.

Measurement process capability

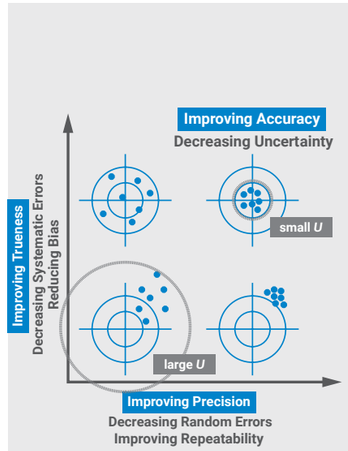
is defined by Cg and Cgk values. It is determined by analyzing the standard deviation (Sigma σ)/precision plus bias/trueness of a measurement system. While standard deviation and bias are quantitative indicators, precision and trueness are qualitative. Usually, a system is considered to have a measurement process capability > Cg, Cgk 1.33. However, this may vary for different industries, companies, or components.

Accuracy,

also called uncertainty, can be derived from the systematic and random errors of a measurement system. Both values must be as low as necessary. Systematic errors are indicated as bias value (quantitatively) or as trueness (qualitatively). Random errors, by contrast, are indicated as standard deviation (quantitatively) or precision (qualitatively).

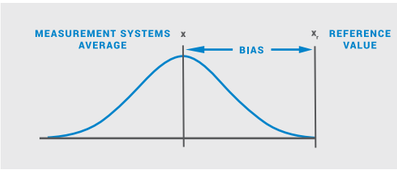
Repeatability

Is calculated regardless of the systematic error of a measurement. It is typically described by standard deviation (σ) computed from a set of repeated measurements.



Trueness

Closeness between the measurement results and the true value. Results can have good trueness, whilst having poor precision. Trueness is quantified as bias.



Bias

Estimate of a systematic measurement error and the difference between the observed average of measurements and the reference value.

Accuracy

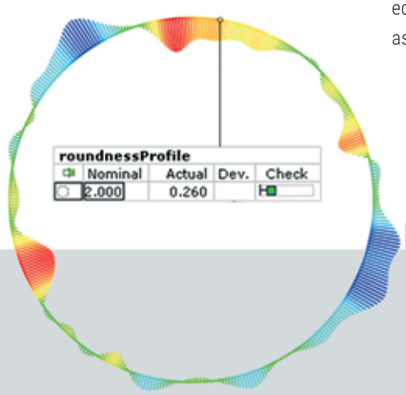
Accuracy is a combination of trueness and precision.

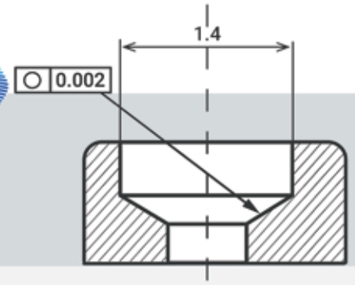
Uncertainty

To calculate uncertainty, precision, represented as repeatability, and trueness, represented as bias, need to be known.

Precision

Closeness of results regardless of where the clustered results fall on the target. Precision is a description of random errors quantified as repeatability.





	RONt/ µm f=20UPR	RONt/ µm f=50UPR	Radius/°
Cg	2.960	2.152	2.911
Cgk	2.098	1.723	1.514

The following example of a roundness measurement (RONt) of valve seats with tolerances of 1–2 µm and opening angles <45° demonstrates the measurement process capability of Alicona´s Focus-Variation.

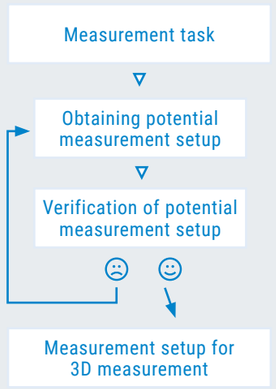
Optical form measurement following GPS standards

One critical factor in determining measurement process capability is the measurement set-up of the optical micro-coordinate measurement device. The measurement set-up describes important aspects such as using the correct objective, illumination, as well as vertical and lateral resolution. These must correlate to the measurement task and the tolerances defined in the technical drawing.

Standards for Geometrical Product Specifications (GPS) are increasingly being adopted by the industry. One of these GPS standards, which is particularly relevant, is defined in DIN EN ISO 1101, describing the verification of form and positional tolerances. GPS standards recommend that the correct measurement set-up is defined and verified in terms of its measurement process capability before carrying out a 3D measurement.

To accurately determine a potential measurement set-up, past experience based on the same measurement task and the technical specification of the measurement system supplier are most beneficial. Alicona recommends to define a potential measurement set-up based on given tolerances in regard to the specified measurement task. Finally, the measurement set-up can be verified and, if needed, optimized following an MSA procedure (measurement system analysis). For the measurement set-up, optimal resolution, illumination, sample positioning and evaluation modes are crucial.

The following figure illustrates the ideal procedure to define a measurement set-up:

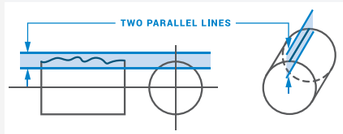


Automation of measurement task

Once the measurement set-up has been determined and confirmed according to MSA, Alicona measurement instruments offer automatic measurement and evaluation of surface roughness and dimensional characteristics. This includes roughness parameters as well as GD&T values such as straightness, roundness, surface profiles, and flatness (described according to DIN ISO 1101 below). [1]

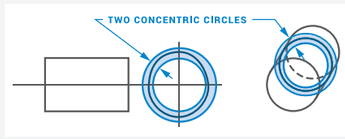
Straightness

Any extracted longitudinal section line of the surface shall be contained between two parallel lines. Tolerance zone: Two parallel lines with a distance t apart (tolerance) in a plane that includes the axis of the surface.



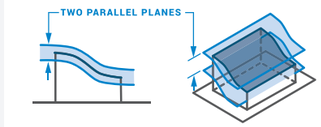
Roundness

also known as circularity, is limited by two concentric circles with a difference in radii in the considered cross-section. Tolerance zone: the considered cross-section, is limited by two circles on a conical or cylindrical surface at a distance t (tolerance) apart along the surface.



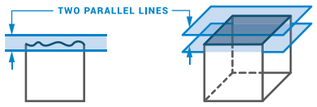
Surface profile

also known as profile of a surface, is limited by two surfaces building a 3-dimensional tolerance zone around any theoretically exact geometrical form. Tolerance zone: the geometrical form is limited by, two surfaces enveloping spheres of diameter t (Tolerance), the centres intersecting the theoretically exact geometrical form.

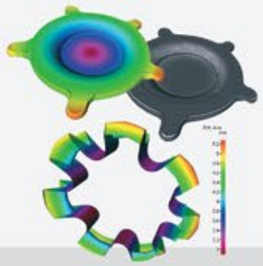


Flatness

References how flat a surface is regardless of any other datums or features and is explicitly given as a flat surface, which is an areal feature. Tolerance zone: Two parallel planes a distance t (tolerance) apart.



[1] EN ISO 1101:2017, Geometrical product specifications (GPS) -- Geometrical tolerancing -- Tolerances of form, orientation, location and run-out



If you want to learn more, feel free to request your personal copy of the Alicona form measurement poster and the new White Paper on GD&T at metrology@alicona.com

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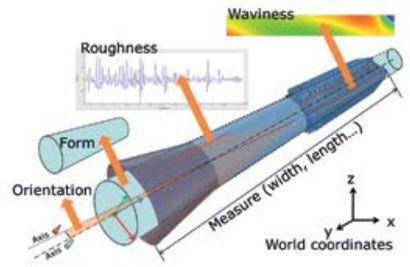
Optical roughness measurement

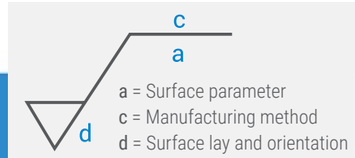
Roughness is crucial for a component's function. Alicona offers optical, high resolution, areal based roughness measurement. This enables the sustainable assessment of a manufacturing process, which is based on a number of user defined evaluation options. The following fundamentals contribute to the best possible use of these options in order to achieve overall optimization.

Regardless of scale, all surfaces share several mutually independent basic characteristics: mounds or other geometrical shapes, waves, and roughness. The magnitude of these three characteristics defines how suitable a workpiece is for a particular function. The form deviation of a machined component is the result of the deviations between the spindle and workpiece axes. Waviness develops as a result of machine vibrations, whereas roughness is a consequence of cutting conditions and tool geometry.



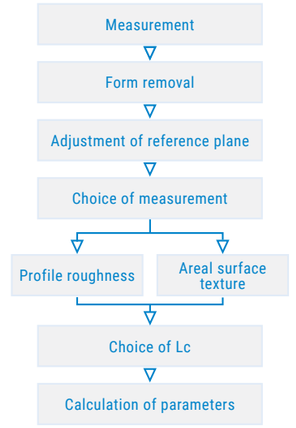
Roughness in technical drawings

Designers draw workpiece contours as sharp, straight lines Translating these drawings into a finished workpiece that corresponds to the design as closely as possible is the task during manufacturing. However, since the realization of a workpiece will always deviate from its idealized drawing, designers must describe the functions of surfaces in the drawing in a way that they can be fulfilled by the final workpiece..



Measurement process

The main prerequisite for ensuring repeatable roughness measurements of the highest possible accuracy is determining the ideal measurement settings. The Alicona Roughness Poster offers a guideline for choosing the correct measurement settings and also provides further information on standardized roughness measurement. The following flowchart illustrates the process for optical roughness measurements:



Form removal

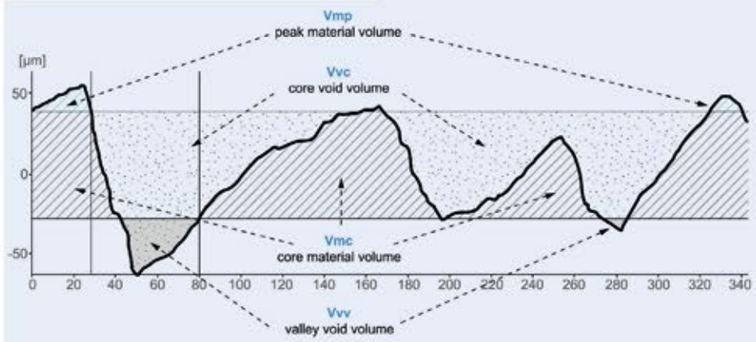
In roughness measurements, if the 3D data record shows a significant form, the real form must first be removed. To achieve this, several forms are available: plane, parabola, cylinder, cone, and sphere. If the form does not correspond to any of the above or is unknown, a polynomial is removed instead.

Profile roughness or areal surface texture

Profile roughness measurements are used for surfaces with directional texture (e.g. turned surfaces) and roughness measurements that must be comparable to tactile values. Areal surface texture measurements, by contrast, are used for:

- Surfaces with non-directional texture
- Measuring the roughness of textured surfaces with complex shapes
- Measuring the flatness of surfaces
- Measuring complex parameters

Volume parameters can distinguish differences between surfaces better than others. Volume parameters are called functional parameters.



The Alicona Roughness Poster contains further information on roughness measurement. Send an e-mail to metrology@alicona.com to receive your personal copy.

The role of Alicona in international standardization

Standards and guidelines are significant success factors for the competitiveness of a company. A study conducted by the German Fraunhofer Gesellschaft in 2011 quantified the economic benefit of standards in Germany at 15 billion Euro annually [1].

In order to make them as practically applicable as possible, standards are usually developed in collaboration with industry experts and universities. The working groups of the most important standardization institution, the "International Organization for Standardization" (ISO), are made up of international manufacturers and users, who are sent by the respective national standardization organizations.

Alicona has been making a valuable contribution to the standardization of quality assurance in various international committees and standardization institutes for more than 10 years now. This includes, for example, the participation in the technical committee TC 213 of ISO, which is responsible for "geometric product specification". As a member of working group 10 (coordinate measuring machines, "dimensional and geometric product specifications and verification") and 16 ("areal and profile surface texture"), Alicona is, among other things, responsible for the development and introduction of series of standards for the non-contact, areal roughness measurement. This contains standards for the definition of corresponding parameters and standards in relation to the calibration of optical, areal measurement devices that measure these parameters (ISO 25178-60x) [2].

In addition to these contributions and involvements, Alicona is a member of the VDI working group for micro-coordinate measurement devices, whose guidelines also often become ISO standards. On a national level, Alicona also works together with the Austrian Standards Institute (ASI) on the development of standards in Austria (Ö-Normen). In the area of applied research, there is a joint project with a Swiss university in order to develop standards for the traceability of optical micro-coordinate measurement devices. The superordinate goal of this cooperation is the expansion of standards within ISO 10360 (acceptance and re-verification tests for coordinate measuring machines). [3]

[1] Neuschaefer-Rube, Ulrich: Normale, Normen und Richtlinien. (Standards, norms and guidelines.) In: Leitfaden zur optischen 3D Messtechnik, Vision Leitfaden 14, (Guideline on optical 3D measurement, Vision Guideline 14), Fraunhofer Verlag (Publisher: Fraunhofer)

[2] Geometrical product specifications (GPS) -- Surface texture: Areal -- Part 6: Classification of methods for measuring surface texture

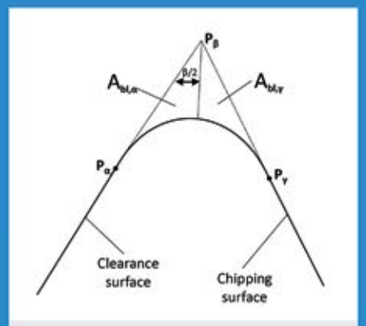
[3] Geometrical product specifications (GPS) -- Acceptance and reverification tests for coordinate measuring machines (CMM) -- Part 8: CMMs with optical distance sensors

With Alicona, the following standards have been established:

ÖNORM 1388	Geometrical product specification and verification (GPS) - Guide for operation and definition of the competence of operators of optical surface topography measurement devices
ISO 25178-6	Geometrical product specifications (GPS) – Surface texture: Areal – Part 6: Classification of methods for measuring surface texture
ISO 25178-606	Geometrical product specification (GPS) -- Surface texture: Areal -- Part 606: Nominal characteristics of non-contact (focus variation) instruments
VDI/VDE 2617, 12.2 (draft)	Accuracy of coordinate measuring machines – Characteristics and their testing – Acceptance and reverification tests for optical CMM measuring microgeometries

Alicona and VDI: Innovators in standardization

Franz Helmli, Head of Research and Development, Alicona
Sophie Gröger, Professorship Production Measuring Technology, Technical University Chemnitz (Germany)



One goal of the VDI guideline is to establish standardized cutting edge measurement. All relevant edge parameters currently under discussion are already implemented in Alicona´s cutting edge measurement systems.

Standards

Development of the new guidelines for the measurement of cutting edges

The defined edge geometry of cutting tools is a decisive factor in the improvement of tool service lives and processing quality. In production technology, there are numerous areas where cutting edges are applied, a comparable measurement of the edges and edge parameters does not yet exist, however.
New guidelines in relation to edge-cutting measuring should now make quality assurance of tools easier for manufacturers and users. For this purpose, the VDI/VDE-GMA technical committee 3.64 "Characterizing and measuring cutting edges" was set up in October 2016 and is headed by DI Franz Helmli, Alicona and Prof. Dr. Sophie Gröger, TU Chemnitz, Germany. In addition to the Association of German Engineers (Verein Deutscher Ingenieure, VDI), other international experts from science and industry also work together on developing new guidelines.
Particularly in focus are new standards for the measurement and evaluation of edges and radii. The goal is to standardize both the description of cutting tools, as well as the approach to the measuring of edges. An initial focus in this case is a uniform definition of edge parameters and of processes to determine these parameters.
Further working points are the definition of framework conditions, models and approaches, supporting the user during their interpretation of the measurements and increasing the reproducibility of the results. Furthermore, a better comparability of measurements and measurement devices should be created.

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Alicona measurements comply with following standards and guidelines:

General

DIN EN ISO 25178-6	2010	Geometrical product specifications (GPS) – Surface texture: Areal – Part 6: Classification of methods for measuring surface texture
DIN EN ISO 25178-606	2016	Geometrische Produktspezifikation (GPS) – Oberflächenbeschaffenheit: Nominal characteristics of non-contact (focus variation) instruments
VIM ISO IEC	2007	International Vocabulary of Metrology – Basic and General Concepts and Associated Terms, 3rd edition
DIN EN ISO 10360-8	2014	Geometrical product specifications (GPS) – Acceptance and reverification tests for coordinate measuring systems (CMS) – Part 8: CMMs with optical distance sensors

Profile roughness measurement

DIN EN ISO 4287	2010	Geometrical product specifications (GPS) – Surface texture: Profile method – Terms, definitions and surface texture parameters
DIN EN ISO 4288	1998	Geometrical product specifications (GPS) – Surface texture: Profile method – Rules and procedures for the assessment of surface texture
DIN EN ISO 16610-1	2015	Geometrical product specifications (GPS) – Filtration – Part 1: Overview and basic concepts
DIN EN ISO 16610-20	2015	Geometrical product specifications (GPS) – Filtration – Part 20: Linear profile filters: Basic concepts
DIN EN ISO 16610-21	2013	Geometrical product specifications (GPS) – Filtration – Part 21: Linear profile filters: Gaussian filters

Surface texture measurement

DIN EN ISO 25178-2	2012	Geometrical product specifications (GPS) – Surface texture: Areal – Part 2: Terms, definitions and surface texture parameters
DIN EN ISO 16610-1	2015	Geometrical product specifications (GPS) – Filtration – Part 1: Overview and basic concepts
DIN EN ISO 16610-61	2016	Geometrical product specifications (GPS) – Filtration – Part 61: Linear areal filters: Gaussian filters
DIN EN ISO 16610-71	2014	Geometrical product specifications (GPS) – Filtration – Part 71: Robust areal filters: Gaussian regression filters
DIN EN ISO 13565-2	1998	Geometric product specifications (GPS) – Surface texture: Profile method; Surfaces having stratified functional properties – Part 2: Height characterization using the linear material ratio curve
ASME B46.1	2009	Surface Texture (Surface Roughness, Waviness, and Lay)[1]

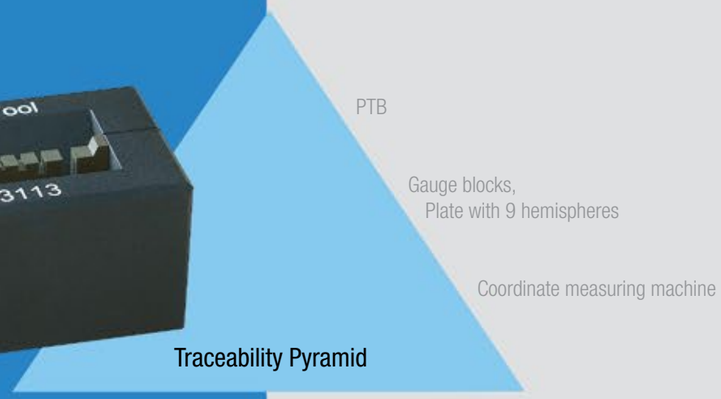
This representation merely offers an excerpt of standards and guidelines, which form and roughness measuring devices from Alicona correspond with.
You can find a full list and more information about the standardization work of Alicona at: metrology@alicona.com

[1] The American Society of Mechanical Engineers, https://www.asme.org (as consulted online March, 15th 2017)

Proving traceability

ALICONA ARTIFACTS

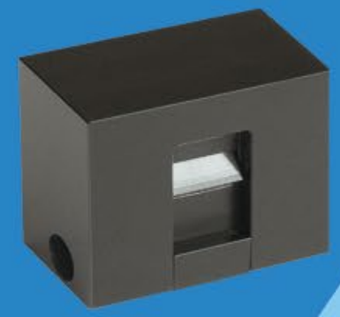
FORM CALIBRATION

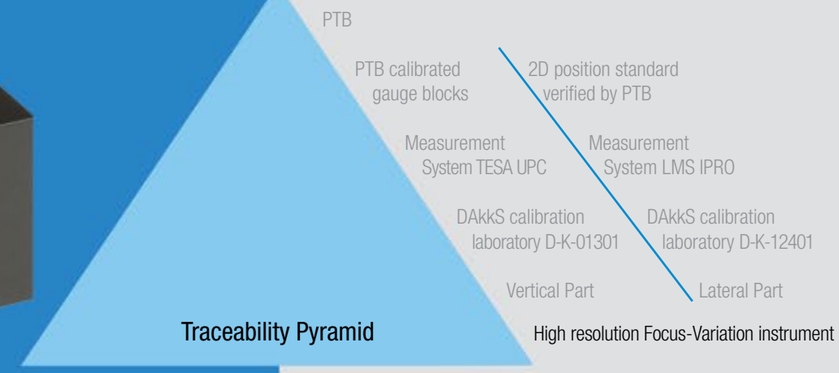


Cylinder Diameter	100µm, 250µm, 500µm, 1000µm
Angles	90°, 60°, 20°
Height Steps	500µm, 1000µm, 2000µm, 5000µm

Standard, traceable to the PTB (Physikalisch-Technische Bundesanstalt, Germany), with miscellaneous form artifacts such as steep slopes, angles, height steps and cylinder diameters. Used for verifying the accuracy of form measurements.

EDGE CALIBRATION

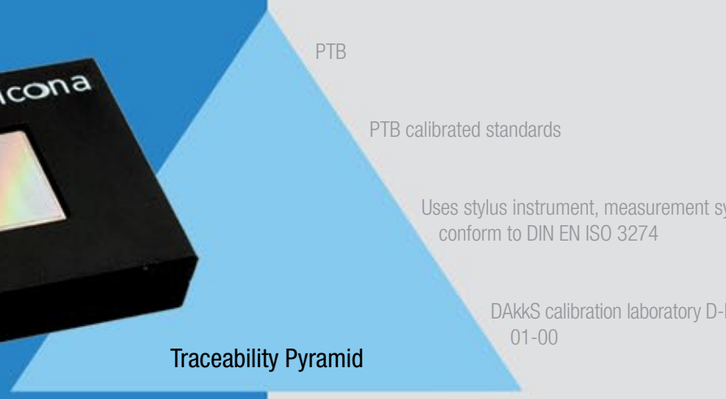




Edge fillet	8µm
Wedge angle	90°

Standard with a radius of 8µm. As its surface is similar to tools, it enables realistic traceability.

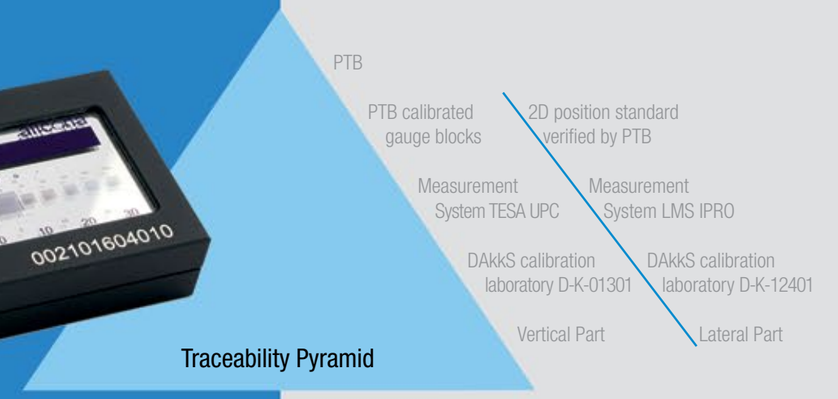
ROUGHNESS CALIBRATION



Sinusoidal Roughness Standard	Ra = 0.1µm Ra = 0.5µm Ra = 3µm

Roughness standard for optical and tactile measurements traceable to the PTB. With this tool, the accuracy of optical roughness measurements is verified. All ISO optical measurement techniques are validated.

CALIBRATION TOOL



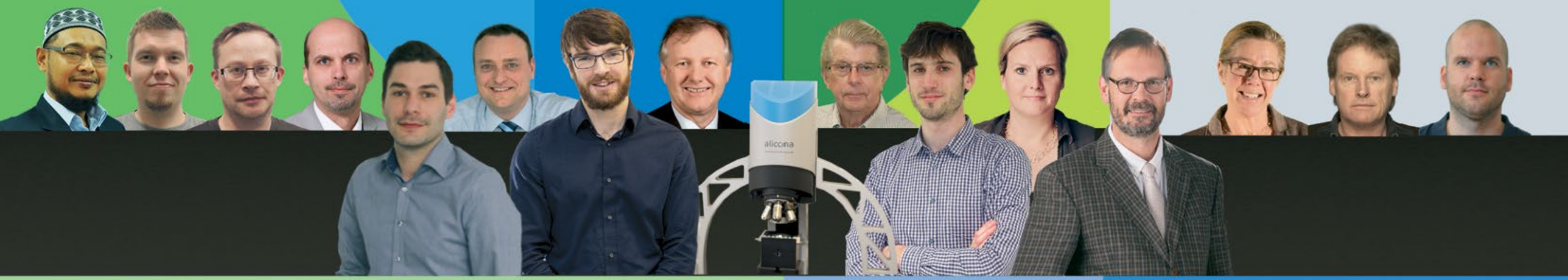
Circle Diameters	2000µm, 1000µm, 500µm, 250µm, 100µm, 50µm
Chess Pattern Pitch	120µm, 50µm, 24µm, 12µm, 5µm, 5µm
Height Step	1000µm
2 Rulers	35mm horizontal length, mark every 50µm 25mm vertical length, mark every 1000µm

Standard, traceable to the PTB, to verify vertical and lateral accuracy. Height measurements help proving the vertical measurement.

Practical Experience

What customers say about Alicona

user case stories



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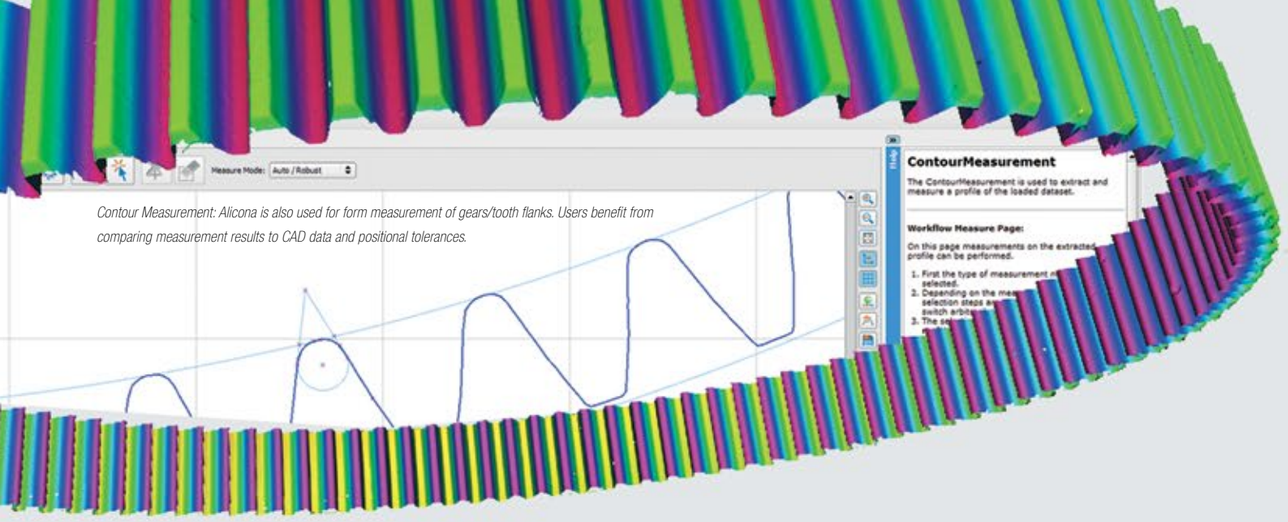
Our customers describe the way they use Alicona for quality assurance purposes. The applications found daily in various fields create additional benefits that you too can experience from using Focus-Variation.

With our 3D optical measurement system we present our user-oriented and sustainable solutions. The application examples mentioned here illustrate the need to meet the requirements of our customers not only from a technological viewpoint, but also satisfy the demands concerning handling, flexibility and servicing. Each of our 3D measurement systems is based on the principle of direct marketability that originates from constant dialogue with Alicona users.

Do you want to take part in development of Alicona measurement solutions? Let us know your requirements: CreativeLab on our online Service Portal- Alicona**Family** is waiting for you!



Contour Measurement: Alicona is also used for form measurement of gears/tooth flanks. Users benefit from comparing measurement results to CAD data and positional tolerances.

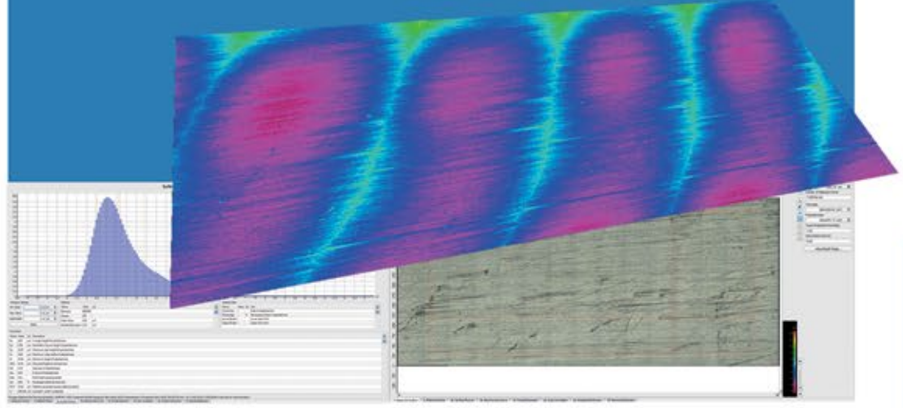
Minimizing refining steps for gears

To help prevent cost-intensive postprocessing, Lund University developed a simulation model to calculate the ideal machine parameters for a form milling cutter. This was to ensure the tool would produce tooth flanks with optimum surface quality. The research team used Alicona systems at Sandvik Coromant to validate the mathematical models and verify their suitability for practical use. “Thanks to the high working distance, we were able to measure the roughness of tooth flanks that were previously inaccessible to us,” Mattias Svahn confirms.

Due to global competition, cost pressure is constantly on the rise. This makes it necessary to increase the efficiency of processes in the manufacture of gears. One of the major cost factors is post-processing, including refining steps such as grinding and honing to ensure the correct roughness of tooth flanks. This process could be minimized if it were possible to produce virtually perfect gears with optimum surface quality that need little to no post-processing. To make this a reality and to ensure gears are produced with the desired roughness, it is critical to calculate the correct machine parameters for the tool used, e.g. for a form milling cutter. The roughness has an effect on gears’ service life, fatigue and uniform transmission of motion and is chiefly determined by the feed rate, possible errors connected to the tool and the machining process. It is therefore of great economical interest to predict which roughness values result from different machine parameters, and how possible error sources in milling affect the cut surface. For this reason, Lund University (Sweden) initiated a research project to investigate this exact question by way of a simulation. The research team developed a mathematical model in order to investigate how machine parameters and possible error sources, isolated or combined, find their impact on the cut surface roughness. This was accomplished in cooperation with Sandvik Coromant, a renowned Swedish tool manufacturer that recently launched a new series of form milling cutters. Alicona systems were used to verify whether the roughness values calculated in the model could actually be produced in reality, and thereby identify error sources in the milling process. Areal roughness measurement enabled Lund University to validate the model at the required level of quality. “We carried out the areal roughness measurement on-site at Sandvik Coromant and got to know Alicona in the process. The high precision and speed of the measurements immediately convinced us to purchase our own InfiniteFocus system,“ professor Carin Andersson explains.

Roughness and positional tolerance

The quality of a tooth flank is determined by both its roughness and its profile accuracy. The roughness of the tooth flank plays an important role in several ways. For example, it directly affects noise generation. The rougher the surface, the noisier the gear. Uniform transmission of motion, on the other hand, mainly depends on the form and positional tolerances of the tooth flank.
It is therefore vital to measure both roughness and form to ensure proper quality assurance of gears. When measuring roughness, it is important to consider the dominant surface structure of gears and choose the appropriate measurement technology for this purpose. Mattias Svahn used an Alicona system, as he knew that mere profile-based roughness measurement would not deliver useful results. ”Profile-based measurement allows me to map the surface only partially. A lot of important information is lost by only a few line measurements along the tooth height and the tooth width.



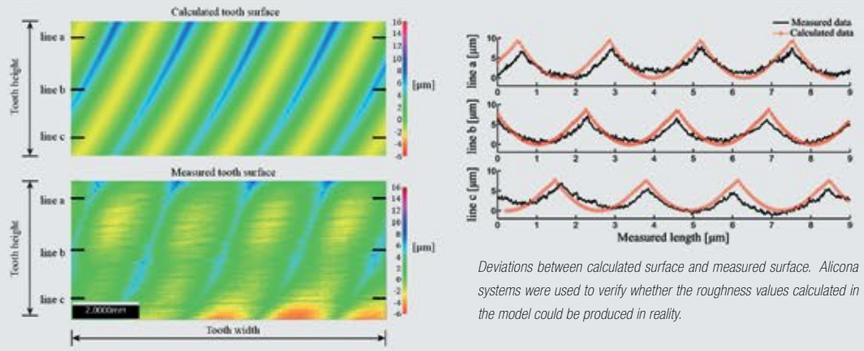
Areal based roughness measurement of a tooth flank. In contrast to profile based roughness measurement, the surface texture parameters Sa, Sq, and Sz allow precise assessment of the surface quality.

The resulting measurement values are simply not useful for validating the calculation model,“ lead researcher and measurement expert Mattias Svahn explains. By contrast, Alicona’s measurement systems make it possible to map the roughness of the entire surface, even of the tooth flanks—fast, repeatably, and at high resolutions. The surface texture parameters Sa, Sq , and Sz allow precise assessment of the surface quality.

Form deviations can be made visible using difference measurement. This is accomplished by comparing measurement results to a CAD dataset and/or form and positional tolerances.

In addition to form and roughness measurement, Lund University also makes use of the visualization of 3D data sets. The large lateral and vertical scanning areas make it possible to map the topography of the entire gear cutting.

”Thanks to Alicona, we have been able to minimize the time and cost-intensive refining steps of gears. We were blown away by the capabilities of the InfiniteFocus system we got to know at Sandvik Coromant. There is no measurement system we know that is capable of measuring critical form and positional tolerances and roughness of tooth flanks in this way with just one system.“
Mattias Svahn, Lund University



Deviations between calculated surface and measured surface. Alicona systems were used to verify whether the roughness values calculated in the model could be produced in reality.

Calculated roughness versus measured roughness: The research team developed a mathematical model in order to investigate how machine parameters and possible error sources find their impact on the cut surface roughness.

At one glance:

- Alicona was used to validate a mathematical model to investigate how machine parameters and possible error sources find their impact on the cut surface roughness.
- In particular, areal roughness measurement helped to validate the model at the required level of quality.
- Sa, Sq, Sz parameters were measured at tooth flanks that have not been accessible before.
- The measurement of form deviations to reference geometry was performed by using difference measurement. This is accomplished by comparing measurement results to a CAD dataset and/or form and positional tolerances.

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Mattias Svahn, Division of Machine Elements: "We were blown away by the capabilities of InfiniteFocus!"

Lars Vedmar, Division of Machine Elements

Carin Andersson, Division of Production and Materials: “The high precision and speed of the measurements immediately convinced us to purchase our own InfiniteFocus system.”

LUND UNIVERSITY

SANDVIK Coromant

“Our objective was to reduce production costs, and that is what we have achieved with Alicona!“

KENDRION

WE MAGNETISE THE WORLD

Optimized valve geometry reduces rejection rates

Precise measurement accuracy and significant reduction in rejection rates were the main reasons for Kendrion GmbH to choose Alicona. Using the optical measurement technology Focus-Variation, Kendrion is able to check the roundness of valve seats in a repeatable and traceable manner, for optimal sealing. This even applies to small valve opening angles and tolerances in the single-digit µm range.

In the automotive sector, high demands are placed on dimensional tolerance and contour accuracy. The Kendrion Group develops, manufactures and sells high quality electromagnetic and mechatronics solutions for industrial and automotive applications. The company’s two business divisions, Passenger Cars and Industrial Drive Systems, are both located at the German site in Villingen-Schwenningen. The product portfolio covers high technology components and systems in the automotive sector, which include diesel and petrol engine injection systems as well as engine management and assistance systems.

Micro-precision components for high pressure control valves are amongst the most challenging for quality assurance items at Kendrion, and are subject to the highest demands on dimensional tolerance and surface quality.
In order to fulfill these requirements, Kendrion uses Alicona optical 3D surface measurement technology for error analysis and control of manufacturing processes.

Reducing production costs and lowering rejection rates

“Our clear objective when purchasing the InfiniteFocus measuring system was to reduce production costs, and we have definitely achieved that.” explains Stefan Steimle, Head of Quality Management. “As issues of valve sealing could be positively correlated to the geometrical properties, and then optimized for the affected components, we have been able to significantly reduce the rejection rate in our production.”

In addition to producing very fine atomization of fuel, injection systems have a decisive control function in the injection of fuel into the combustion chamber of a diesel engine. The high pressure control valves manufactured by Kendrion regulate the necessary system pressure, in ranges currently extending up to 2700 bar.

The precise roundness and uniform surface finish of the valve seat is crucial in ensuring the correct function of the valves. In order that the pressure matches the requirements of the control unit precisely, the contour accuracy of the valve seat must be measured and analyzed for the slightest deviations. This requires measurement solutions that are both flexible and highly accurate. They also have to be suitable for measuring difficult to access geometries and smallest dimensions of valve elements as well as facilitate the analysis of critical surface structures.
“Of course we reviewed various manufacturers when looking for a measurement system. Other methods initially appeared attractive, but did not meet the requirements at closer inspection”, explains Steimle. “Measurements must be performed rapidly, but must not compromise accuracy. This is where Alicona offers the most effective method, and has impressive measurement accuracy even with very tight tolerances.”
The high resolution measurement systems also measure deviations in valve seat roundness in the tolerance range of 1-2 µm. This represents a special challenge due to the small opening angle of the valve seat cone (<45 °). Traditional optical measuring systems, which typically measure along the cone axis, reach their limits of the detectable flank steepness with this application. With Alicona, these measuring tasks can be realized, based on Focus-Variation technology that allows for measuring small radii and flanks of up to 87°.
Quality assurance manager Stefan Steimle explains: “Alicona allows us to measure geometry at component positions, which were difficult to reach using tactile means. As an example, this includes measurement of the cone axis concentricity relative to the outer cylinder axis.”

Optimum concentricity prevents one-sided wear on sealing surfaces, which requires deviations of the axes to be reliably assessed within a range of <0.0100mm. The InfiniteFocus G5 measuring system allows the component to be measured from different directions. This complete measurement of the contour can be realized using the highly precise Advanced Real3D Rotation Unit. The individual measurements are merged into a complete high precision 3D data set.

In addition, the roughness on the valve seat surface is measured both profile based and area based (ISO 25178). In order to be able to determine whether optimum conditions prevail for flow of the medium through the valve area, the inner cylinder diameter and the edge radius as well as the absence of burrs between the inner cylinder and the cone shape of the valve, are also measured.
The decisive factor here is that the entire measurement sequence can be stored in a program and then repeated completely free from operator intervention at any time.

Stefan Steimle,
Head of Quality Management, Kendrion (Germany)

“Alicona offers the most effective method, and has impressive measurement accuracy even with very close tolerances.“

	RONt/ µm f=20UPR	RONt/ µm f=50UPR	Radius/°
Cg	2.960	2.152	2.911
Cgk	2.098	1.723	1.514

With Alicona deviations in roundness (RONt) are measured for tolerances in the range of 1-2 µm. Measurements are traceable and repeatable and can also be performed with small opening angle of the valve seat cone. Measuring instrument capability is also in accordance with requirements (Cg and Cgk values >=1,33).

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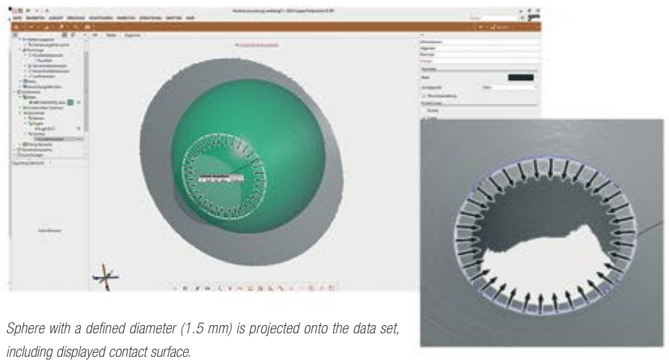
Using Alicona, Kendrion is able to measure the roundness of valve seats in a repeatable and traceable manner for optimal sealing.

Optical measurement solutions for the entire automotive process chain

In addition to the key functional parts of its pressure control valves, Kendrion also optically measures small plastic and elastomeric parts. One of the problems with previous tactile measurements was the deformation of the component. “Being able to assess the area of functional surfaces, such as bearing and sealing components, has provided us with critical new insights. We are also impressed by the possibility of overall 3D assessment and 3D surface contour measurement”, Kendrion concludes.

3D measurement of the valve seat in true color

3D measurement of the valve seat in pseudo color



Sphere with a defined diameter (1.5 mm) is projected onto the data set, including displayed contact surface.

Quality assurance in highest precision

Precision, product safety, and consistently high quality standards—these are the strict requirements Profiltech GmbH has to meet. At the same time, the company’s customized solutions demand a great deal of flexibility. In order to monitor the quality of its special tools used in the production of precision-milled profile strips, Profiltech employs high-resolution optical 3D measurement systems by Alicona. Thanks to the repeatable and traceable measurements by these systems, Profiltech has optimized its milling process and increased the service life of its tools significantly.

In the manufacture of stamped parts, using precision-milled profile strips, also called contour strips, has become a preferred production method. The strips are usually made from copper or other common millable non-ferrous alloys and their use can in many cases replace separate processes like stamping. Similarly, assemblies whose constituting elements would normally need to be produced from several strips can be manufactured more economically in one single stamping operation.

Optical 3D measurement of special tools for the precision milling of profile strips

Based in Germany, Profiltech is a world market leader in the manufacture of precision-milled profile strips. Its customers include companies from a wide range of industrial sectors, such as electrical engineering, the automotive industry, information technology and computer engineering, as well as from other high-tech areas. The company’s profile strips are used in e.g. the manufacture of connectors, contacts, and complex semiconductor components.

In virtually all of these applications, the printed strips and their fine geometries are highly customized individual solutions. Consequently, the development and production of customer-specific printed strips must be accompanied by innovative and process-integrated quality assurance.

For this purpose, Profiltech uses high-resolution optical 3D measurement systems by Alicona. Corinna Ruess, Technical Director at Profiltech: “We use special in-house-developed machines and milling cutters for the machining of our printed strips. Since 2014, we have been relying on the optical measurement system InfiniteFocus to assess the quality of these special tools.”

Profiltech’s milling tools are made of highly advanced cutting materials that are known for their extreme hardness and stability such as polycrystalline diamond.

The company’s specially developed milling technology makes it possible to produce profile strips with highly precise channels, smallest radii of 50 µm and above, and Ra roughness values less than or equal to 0.20 µm. “In order to achieve the complex and fine milling geometries and grooves of the profile strips, we use the InfiniteFocus system during both production and quality control of the finished milling tool,” Corinna Ruess explains.

Robust measurement of cutting-edge geometry and chipping

Precise measurements are carried out particularly with regard to geometry and chipping of the cutting edge. This reduces the risk of cracks and improves edge stability. Thanks to the LED ring light, edges with varying surface and reflection properties can be measured quickly and intuitively.

“In addition to the edge radius, we also carry out measurements on all other relevant edge parameters such as clearance angle, wedge angle, and rake angle,” says Ruess. “It was only when we started using Alicona that we became able to verify the almost inaccessible areas just behind the cutting edge.”

One of the many demanding customer-specific applications is the production of power LEDs. The fine geometries and extremely small dimensions of the components can only be achieved at the required level of precision by using profile strips. The trend toward ever smaller and more complex structures as part of miniaturization posed a new challenge to Profiltech. These high customer expectations made it a logical step for the company to turn to Alicona solutions. Ruess: “Tactile systems and light microscopes we used to work with couldn’t deliver satisfactory results and weren’t able to achieve the required depth of focus. Due to the close manufacturing tolerances of up to ±4 µm and ever increasing requirements with respect to the precision of our products, we decided to work with Alicona.”

Improving quality and service life of milling tools

To Ruess, the advantages of using InfiniteFocus for quality assurance are obvious: “By using Alicona systems in the edge preparation and quality assurance of our tools, we have been able to significantly increase their service life and optimize them even further.”

For Profiltech’s customers, the highly variable cross-sections of the profile strips are a significant advantage, as they allow for flexible manufacturing of thickness transitions. At the same time, close thickness tolerances can be achieved in longitudinal and cross direction during the milling process.

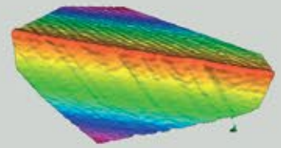
Technical Director Ruess describes the advantages of precision-milled profile strips: “By using our products, our customers reduce tool costs, as folding and coining during the stamping process are no longer necessary. The increased stamping speed also enhances productivity.”

Profiltech takes great care to ensure highest material quality, meaning the stamping process must not create any additional stress inside the material. Alicona’s measurement systems support Profiltech in making sure the milling does not affect tensile uniformity, hardness, and electrical or thermal conductivity across the profile width of the strip.

Additionally, it is possible to assess chipping along the edge and carry out profile-based and areal measurements of tool roughness. True-color 3D surface visualization provides a detailed view of the strip surface and makes it easy to detect faults. Potential form deviations and tool wear can be identified using difference measurement, which automatically compares the actual geometry to target geometry or a CAD dataset.

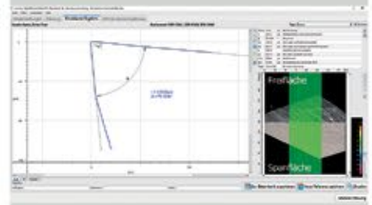
Ruess: “Putting our trust in Alicona’s products for quality assurance was justified. With the support of their systems, we continue to provide the safest and most precise solutions to our customers.”

Corinna Ruess, *Technical Director at Profiltech: “Using Alicona we were able to optimize our milling process and increase the service life of its tools significantly. “*



3D measurement in pseudo color. Verification of roughness across the entire surface.

Verification of height differences with 3D measurement in true color.



Measurement of radius and form of cutting edges in the range of 3 µm for an increased quality and service life of tools.

Measurement of special milling tools with Alicona - Corinna Ruess and Manuel Herrmann

“With Alicona local surface defects on aerospace components are now automatically quantified.”

Customized solutions for innovative technologies in aerospace

Automated measurements along with repeatable and traceable 3D measurement data convinced the technology transfer center Metallicadour to choose Alicona. For developing innovative tool and automated machining solutions in aerospace applications, they verify geometric dimensions and surface finish on tools and components using optical 3D metrology.

New applications in the aerospace industry and the rapid pace of technological change lead to an increasing demand in tooling. With Alicona’s optical measurement technology, the expert team at Metallicadour found the right solution for measuring complex geometries and hard-to-machine materials, such as titanium, composites and heat-resistant alloys.

Metallicadour is a resource and technology transfer center devoted specifically to the metal industry and fields of machining, assembly and process automation. It was founded in 2015 with the academic support of ENIT, the National School of Engineering in Tarbes in France. The center is located in the heart of the Adour Industrial Basin in France and aimed particularly at SMEs in aeronautics. The center is supported in its work by the major local aircraft manufacturers, among them Safran, Daher and Dassault. Metallicadour enables component manufacturers to test and automate machining processes and demonstrate the interest in new cutting technologies, such as very high pressure lubrication and cryogenic turning.

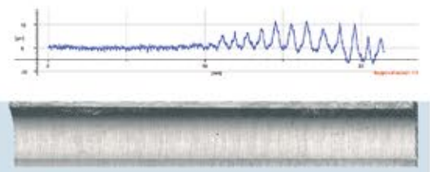
Testing of new machining tools and technologies for aircraft construction

Verification of form and roughness has a major influence on the service life of a tool and can help to significantly reduce wear and chatter for an improved surface finish of components. “Cutting tools for machining aerospace components have to meet the highest precision requirements for high-speed machining. Therefore, geometry and edge conditions need to be addressed”, Pierre Courbun, Development Engineer at Metallicadour explains, “With Alicona we found what we were looking for: A measurement solution that provides us with precise, repeatable measurements as well as simplicity and flexibility in use.”

As the measured parts and requirements vary, Courbun and his colleagues were pleased to find a solution for all kinds of measurement tasks, including form and roughness measurement of mills, inserts and drills. Pierre Courbun: “Our components often show steep flanks, deep lengths and light refection. With Alicona’s optical measurement system, we measure small surface connection radii and the geometry of very complex surfaces. We are also able to verify roughness on components with very smooth surfaces or parts that are way too small to be measured tactile. Laser solutions are often not precise enough for our measurement tasks.”

New insights into cutting processes and wear behavior of tools

Based on the technology of Focus-Variation, the measurement system allows for profile (Ra, Rq, Rz) and area-based measurements (Sa, Sq, Sdr). With up to 500 million measurement points it provides robustness of the measurement data. Accuracy of roughness measurements can be verified with a roughness standard that is traceable back to the PTB (National Metrology Institute of Germany).



By altering rotation speed and feed rate, Metallicadour investigates milling parameters for an optimum surface finish of aeronautic components.

Pierre Courbun,
Development Engineer at Metallicadour
“With Alicona we verify roughness on components with very smooth surfaces or parts that are way too small to be measured tactile.”

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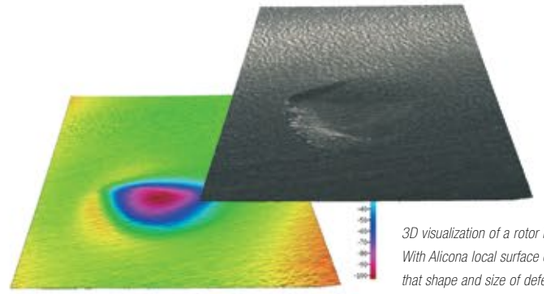
3D visualization of a turbine disc fir-tree root. Deviations from nominal geometries are automatically measured so that out-of-tolerance features are quickly assessed.

3D visualization of an injector combustion chamber. The optical measurement system by Alicona is used to verify geometry, positioning and functional dimensioning.

The 3D measurements can be compared against CAD data or reference geometries for verification of accuracy. This helped Courbun and his partners in their research on understanding the cutting phenomenon and related indicators: “With our measurements we compare different tools and materials to investigate wear behaviour. We study the correlation between cutting forces, wear behaviour and performance of the tool, respectively the roughness generated by the tool over its full life cycle. Moreover, we also investigate the links to the matter of surface material as well as the change of mechanical surface tension”. Alicona is also used in the development of new machining solutions. Courbun continues: “We are working on an automated manufacturing solution, where the workpiece is processed by a milling robot. Following each process step, the component is automatically measured for verification of dimensions and possible deviations from the target geometry. This is implemented by another robot that is equipped with Alicona’s optical sensor. Based on the high-resolution measuring data, the machine automatically modifies the process parameters for further manufacturing.”

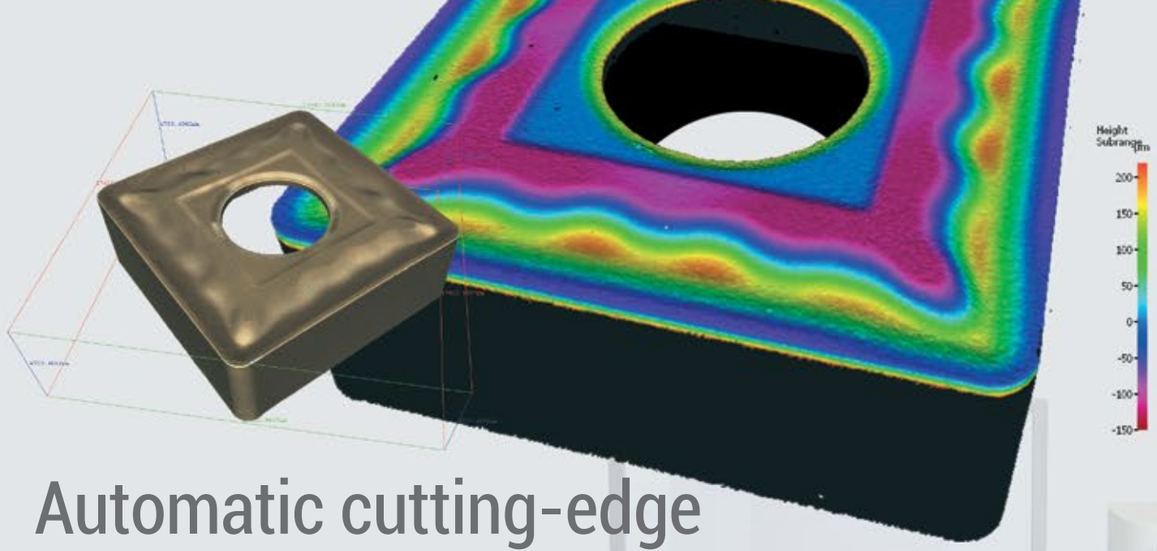
Robot-based solutions for automated defect detection of aircraft components

In joint research and development projects, Metallicadour and Alicona also implemented automated defect measurement on rotor blades as well as new collaborative robot solutions (cobots) for quality control of landing gears, turbine discs and large components. Defects on rotor blades as well as engine and other aircraft components are safety-critical when they cause stress points which in turn create a crack. When the local stress concentration becomes too high or the crack reaches a critical size, the remaining material cannot support the applied loads. This may result in a fracture or sudden rupture. The defects can be caused by machining errors, corrosion or external influence, i.e. the impact of stones and debris. “Before, components could only be evaluated by the unaided eye of an expert. With Alicona local surface defects are automatically measured, so that shape and size of defects can be quantified in MRO and process development”, Pierre Courbun points out. If the defect is outside a defined tolerance it must be removed by dressing until it is acceptable or, if not possible, the workpiece has to be scrapped and replaced.



3D visualization of a rotor blade surface in true and pseudo color, With Alicona local surface defects are automatically measured, so that shape and size of defects can be quantified easily.

With Alicona, Metallicadour develop an automated manufacturing solution, where the workpiece is processed by a milling robot. After each process step, the component is tested for possible deviations from the target geometry by an Alicona measurement robot.



Automatic cutting-edge measurement in tool production

Tool life, geometry, and stability largely depend on proper edge preparation. Tool Flo, located in Houston, Texas, is a manufacturer of carbide cutting tools such as inserts for threading, turning, and milling. The company uses Alicona's optical 3D measurement systems in the quality assurance of inserts. "Alicona's systems allow us to carry out high-resolution measurements of the geometry of cutting edges and the chipping and roughness of cutting surfaces in a fully automated process free of possible user errors," president Dennis Flolo confirms.

Edge preparation reduces chipping and increases edge stability. This improves the edge strength of precision tools. As a result, tool life and process reliability of machining tools are enhanced, which in turn leads to better workpiece quality. Tool Flo uses the EdgeMaster, Alicona's optical 3D cutting-edge measurement system, in the production-integrated quality assurance of inserts. Alicona's tool measurement systems are used in mold and tool making in particular due to their capability for repeatable and traceable high-resolution measurements of complex geometries, small radii, and steep flanks. This also makes them the perfect tools for verifying edge geometries.

Measuring the micro-geometry of cutting edges

Since its founding in 1978, Tool Flo has become a first-rate supplier of carbide tools for threading, grooving, turning, milling, and other special purposes. Using the latest in CNC grinding technology to ensure flawless edge preparation, the tool manufacturer produces inserts with edge radii of 2.5 µm–0.1 mm. At this level of manufacturing precision, a measurement system capable of highest resolutions is required to accurately inspect a tool's edge. "Before we became aware of Alicona's products, we used a profile projector to measure edge preparation. The system simply wasn't precise enough to accurately identify edge radii in the micrometer range. It was only after switching to the EdgeMaster that we became capable of high-resolution measurement and precise mapping of edge shapes," president Dennis Flolo explains. The EdgeMaster has made it possible for Tool Flo to map edges using two radius parameters, including a so-called ellipse fit. This is in contrast to conventional methods that use only one radius parameter. "When trying to measure the many undercuts and chamfered edges on inserts, our old measurement system quickly reached its limits. Now we're capable of measuring even complex geometries at resolutions previously unknown to us, and the results are traceable as well," Dennis Flolo says, contrasting the old profile projector with the EdgeMaster.

Apart from radii, Tool Flo also uses the EdgeMaster to verify edge parameters such as the clearance, wedge, and rake angles. True and projected bevel lengths of the cutting edge are also measured. In addition to mapping the cutting edge's geometry, Tool Flo also inspects it for chipping. This reduces the risk of cracks and increases tool life. "Thanks to Alicona, we have been able to eliminate all guesswork regarding edge geometry," CEO Dennis Flo explains.

Automated measurement as part of the production process

Manufacturing tolerances in the micrometer range make it impossible for Tool Flo to accept measurement errors. However, conventional measurement systems often struggle to provide solid high-resolution measurement results in production environments. For this reason, Tool Flo relies on Alicona's fully automatic optical 3D measurement systems to ensure highest measuring accuracy in the production process. With the EdgeMaster, Tool Flo is equipped with a measurement system that eliminates all sources of user error and therefore provides unambiguous and conclusive measurement results. The system offers repeatable and traceable high-resolution measurements, even when subjected to vibrations, extraneous light, and fluctuations in temperature. Reference category and tolerances only need to be set up once. Afterwards, the EdgeMaster carries out measurements without requiring the user to adjust any further settings. The user simply places the insert into the respective grip, starts the measurement, and, after a few seconds, receives the measurement log. The measurement range is automatically selected by the system according to the predefined measurement area. "We use the EdgeMaster as part of our production process. It's easy to set up and can be operated by all of our employees without any special training," Dennis Flolo on the advantages of the optical 3D measurement system in the production process.

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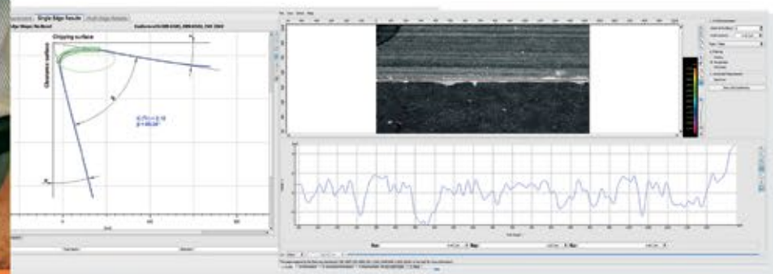
"Since 1978 Tool-Flo has become a prime supplier of carbide inserts for threading, grooving, turning, milling and specials of various styles. We have been looking for years for quality control inspection systems offering what Alicona supplies. Others have given us promises, Alicona showed the proof. We are convinced about the accuracy and repeatability of the tool measurement capabilities. This brought us to a new level of quality beyond belief."

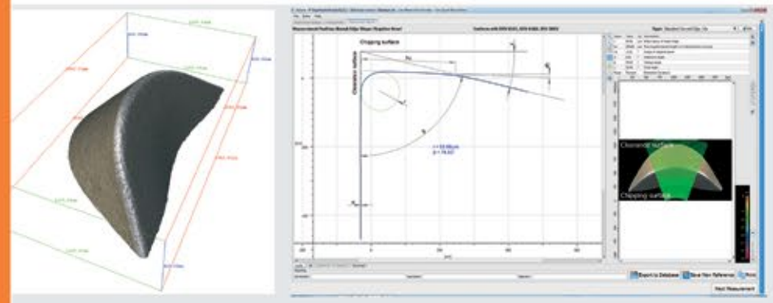
Dennis Flolo, CEO Tool Flo Manufacturing

3D data set of a used tool. With Alicona's EdgeMaster, Tool Flo benefits from repeatable and traceable measurements, even when subjected to vibrations, extraneous light, and fluctuations in temperature.



Measurement of edge roundness using two radius parameters. "It was only after switching to the EdgeMaster that we became capable of high-resolution measurement and precise mapping of edge shapes," president Dennis Flolo explains.

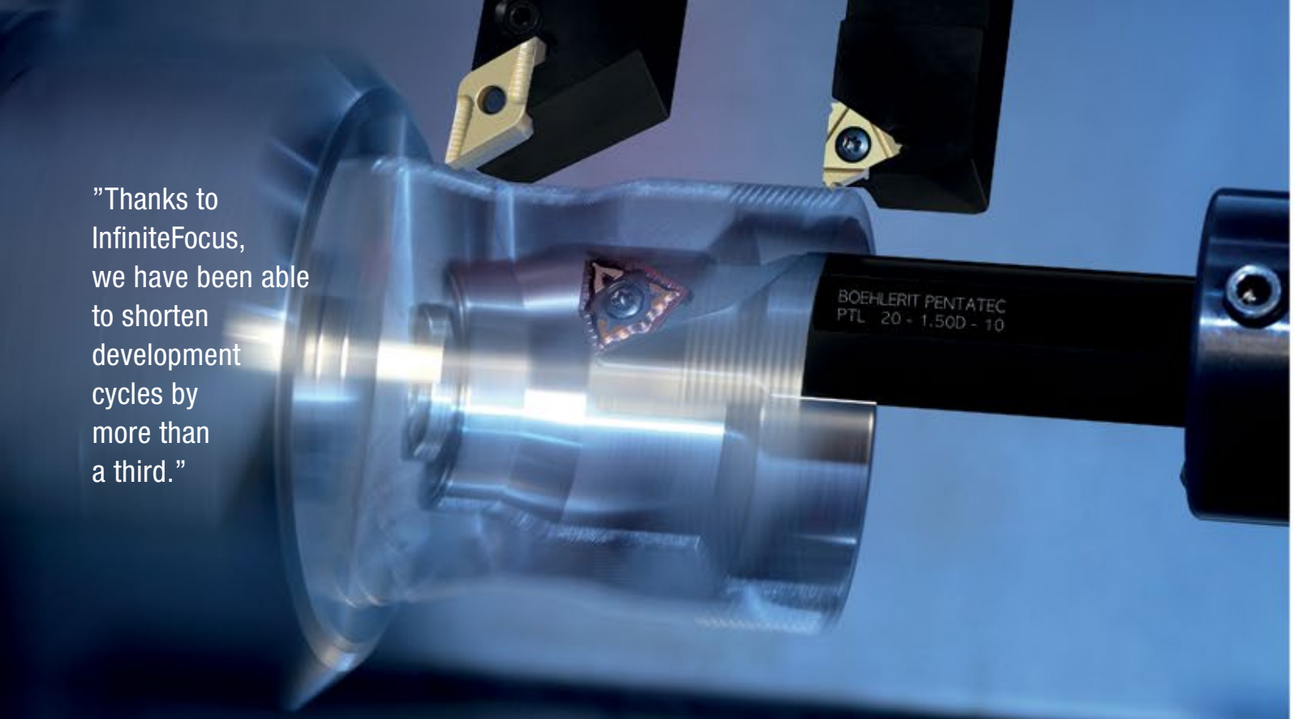
Chipping measurement of used edge to reduce the risk of cracks and to increase tool life. Ra, Rq, Rz… values along the edge make edge defects measurable and visible.



3D measurement of an insert with a curved edge. "When trying to measure the many undercuts and chamfered edges on inserts, our old measurement system quickly reached its limits. Now we're capable of measuring even complex geometries at resolutions previously unknown to us", Tool Flo says.

The following fully automatic measurements of inserts are carried out with Alicona systems as part of the production process:

- Edge radii from 2.5 µm to 0.1 mm
- Measurement of undercuts and chamfered edges
- Profile-based roughness measurement to inspect for chipping
- Deviation from dimensional tolerances



”Thanks to InfiniteFocus, we have been able to shorten development cycles by more than a third.”

Shortened development times in prototype construction

At Boehlerit, an Austrian manufacturer of carbide cutting materials, quality assurance starts at the very beginning of the production process. Alicona measurement systems are used to optimize stamps in the company‘s own pressing tool department. Additionally, the InfiniteFocus measurement system makes the entire manufacturing process of inserts more economical by reducing development times by 30 %. This makes it possible to launch new products faster.

”When it comes to manufacturing complex insert geometries, it’s all about the correct tool,” emphasizes Alfred Maier, Head of Quality Assurance and Quality and Environmental Management at Boehlerit. ”Manufacturing inserts is a cost- and time-intensive process. This means that quality assurance can’t apply to the finished tool only,” he continues, describing the measurement strategy of the Austrian manufacturer of carbide tools. Alfred Maier’s concept of quality assurance starts at the very beginning of the manufacturing process, in mold making. At the Kapfenberg plant in Styria, Boehlerit relies on Alicona’s optical measurement systems in their pressing tool department. The Boehlerit experts in the areas of metallurgy, coating technology, and pressing technology use Alicona’s high-resolution 3D measurement system InfiniteFocus in combination with a motorized rotation unit. This allows them to optimize the clearance between stamp and die, and to measure the complex geometries of inserts in a fully automated repeatable process.

Shortened development times despite increasing complexity

”To receive precisely manufactured tools, stamps must be accurate themselves,” Alfred Maier explains. For this reason, Boehlerit places a great deal of emphasis on manufacturing ideal stamps for over 6000 different types of inserts at their own pressing tool department. Ideal stamps are produced by ensuring the clearance between stamp and die is as small as possible, as this reduces wear. To accomplish this, Boehlerit uses the InfiniteFocus system to measure the aligned stamp and die, determining the best clearance value.
The optical high-resolution measurement system is then employed fur further measurements. Boehlerit verifies post-processing and corrective steps carried out on the pressed raw part to achieve required dimensional accuracy and surface quality. Naturally, the best and most economical scenario for Boehlerit’s quality assurance is if little to no post-processing or corrections are necessary, as refining steps such as grinding are expensive. In this respect, the InfiniteFocus system combined with a motorized rotation unit has already paid off for the company. Thanks to the system, Boehlerit has been able to reduce post-processing significantly and corrective steps have also been rendered much more efficient. This has shortened the overall product development time to be ready for serial production. Alfred Maier explains: ”We used to inspect our pressed raw parts with tactile measurement devices. These quickly reached their limits, especially when it came to measuring complex geometries. The inserts we manufacture today don’t have any straight edges anymore. Today´s geometries with undercuts simply can‘t be mapped with tactile methods.“ He continues, describing the improvements with optical metrology: ”With InfiniteFocus, we are able to manufacture complex geometries far more accurately and require less corrective grinding. For example, we have been able to significantly reduce burrs.“ Gerhard Melcher, head of segment turning and milling and head of Marketing at Boehlerit, expresses these advancements in terms of numbers: ”We used to have product development times of up to 1.5 years. Thanks to InfiniteFocus, we have been able to shorten development cycles by more than a third. Today, despite growing complexity of edge geometries, our machining tools are ready for launch in less than 10 months.“

BOEHLERIT
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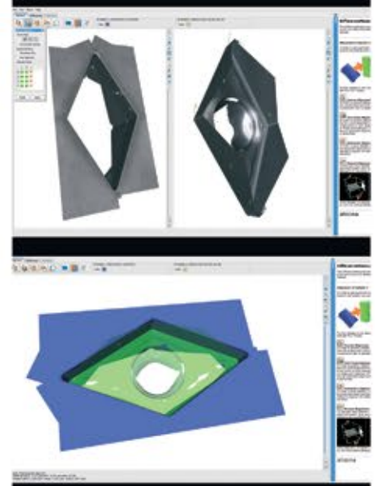
”With Alicona, we have reached the next level in the manufacture of tools with complex geometries. Thanks to the fast and highly accurate measurement technology, we are able to manufacture also special tools precisely and economically. We are proud to be using one of the world‘s leading measurement systems -if not the leading measurement system -with Alicona.”

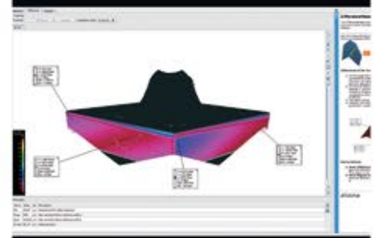
Gerhard Melcher, head of segment turning and milling & head of marketing

All relevant edge geometries in one measurement cycle

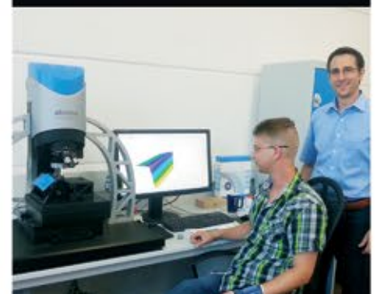
As edge geometries grow in complexity, quality assurance and measurement systems are subject to ever increasing requirements. This translates to enormous pressure on those responsible for quality assurance. ”We are expected to work fast and to not keep production waiting. At the same time, measurements need to be precise, valid, and repeatable,” Alfred Maier explains. With Alicona, Boehlerit has found the ideal partner to meet these requirements. The quality assurance department profits greatly from the fully automatic motorized rotational unit. Markus Peihser, measurement technician at Boehlerit, describes the advantages: ”The rotation unit allows me to automatically measure all relevant geometries and edge parameters in just one measurement cycle. There is no need for me to reposition the part in the grip.” Another feature that quality assurance profits from are the system’s capabilities for importing external datasets. These make it possible to automatically measure dimensioning. Additionally, deviations are also displayed graphically. ”Undersizes and oversizes are also visualized using a color coding. As a result, we become aware of faults much faster, avoid time-consuming corrections, and accelerate the process as a whole,” Peihser points out. The high repeatability of InfiniteFocus‘s measurements has become another important factor for Boehlerit to boost efficiency. Gerhard Melcher, Head of Marketing: ”We are also a supplier and development partner to other tool makers. Our customers demand extensive documentation and repeatability of measurements. Regardless if you measure today or tomorrow, the measurement results have to be the same.“



Carbide specialist Boehlerit uses Alicona in pressing tool construction in order to verify the clearance between the stamp and die. For this purpose, die (here: purple) and punch (here: green) are aligned.



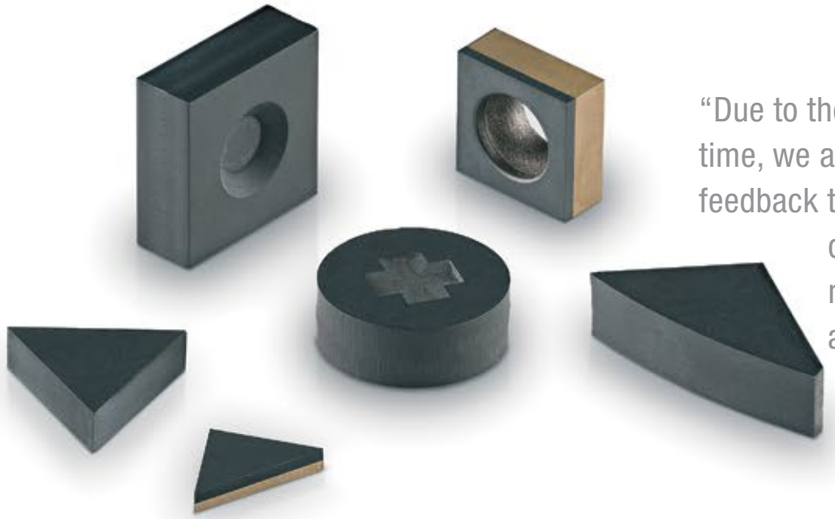
The 3D data sets of die and stamp are automatically superimposed. The resulting clearance is actually visualized by color coding and can also be accessed numerically at all points.



***Alfred Meier,** Head of Quality Assurance and Quality and Environmental Management (right) and Markus Peihser (left) in the machining laboratory of Boehlerit. Peihser about InfiniteFocus: “I can measure all geometries and edge parameters relevant to me in a single measuring run, without having to reclamp the part.“*

Boehlerit uses Alicona systems to carry out the following measurements:

- Measurement of the clearance between stamp and die
- 3D measurement of the geometry of pressed raw parts
- Numerical verification of corrective processes and post-processing such as grinding
- Automatic measurement of form deviations
- Full form measurement of the geometry of inserts with Real3D technology



“Due to the short measurement time, we are able to provide feedback to the production route quickly and adapt machine parameters accordingly.”

Accelerated product development of supermaterials

In their production of supermaterials, the global supplier Element Six was searching for a measurement solution to support them in their research, development and quality control. Two Alicona measurement systems now enable them to optimize the edge preparation of diamond cutting tools and accelerate quality assurance.

‘Supermaterials’ is a term that includes manufactured synthetic diamond as well as cubic boron nitride (CBN), tungsten carbide and silicon cemented diamond. Element Six, a member of the De Beers Group of Companies, produces specialised, innovative high performance products from supermaterials, including materials for machining and grinding metals in automotive manufacturing, cutters for oil and gas drilling and optical windows for high power laser systems.

Optical 3D measurement of synthetic diamond supermaterials

At their Global Innovation Centre (GIC) in Harwell, UK, Element Six develops synthetic diamond supermaterials for a wide range of industrial applications. Within cutting and grinding applications, this means developing new polycrystalline cubic boron nitride (PCBN), polycrystalline diamond (PCD) and diamond or CBN grit for precision metal cutting and grinding operations. In order to fully test these new materials in industry relevant applications, Element Six produce ISO cutting inserts to be used in metal cutting tests on lathes and milling machines, where in-process forces, tool wear and workpiece surface quality are measured and analysed. Fast feedback to the technical teams developing the tool materials is key to rapid innovation. With InfiniteFocus, Element Six has a single measurement system that accelerates this development feedback and provides the flexibility for use across its varied application testing program.

Matthew Goulbourn-Lay, Senior Advanced Manufacturing Research Engineer at Element Six explains: “We have been using Alicona for more than a decade now. Initially, we needed a system that could quickly and accurately measure tool geometries and wear scars. Before, we would have to take many different measurements using various systems and equipment. With Alicona we have a single system from which all our measurements and analysis can be taken.”

Optimizing the edge preparation of cutting tools

In the manufacture of ISO cutting inserts for testing purposes, Goulbourn-Lay’s team use the Alicona systems to speed up their quality control processes. A poor edge preparation can mean edge defects, micro-breakages, burrs, poor surface finishes leading to non-optimal cutting performance. The verification of geometry and surface finish is therefore indispensable. Element Six uses the optical 3D measurement system to measure parameters like chamfer angle, hone radius dimension and chamfer width to within 3 microns. Due to its special technology, InfiniteFocus is able to accurately measure the most complex cutting tool geometries with even very steep surface slopes.

Andy Baker, *Precision Test Operator at Element Six, uses Alicona on a daily basis for the measurement of insert geometries or tested tools.*

At their Global Innovation Centre in Harwell (UK), Element Six develops new polycrystalline cubic boron nitride (PCBN), polycrystalline diamond (PCD) and diamond or CBN grit for precision metal cutting and grinding operations.

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“With InfiniteFocus we have a single system from which all our measurements can be taken.”

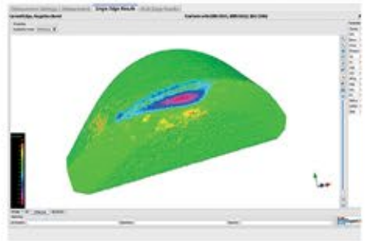
Matthew Goulbourn-Lay,
Senior Advanced Manufacturing Research Engineer at Element Six:
“Using Alicona, we are driving innovations in the development of new materials.
We are now working with two Alicona measurement systems.”

Fast measurement results for quick feedback to the production route

Due to the short measurement time, feedback to the production route can be provided quickly and machine parameters adapted accordingly. Also, InfiniteFocus provides true colour information for each measurement position, which is perfectly registered to the height data. Chipping in the micro- and submicrometer range is visualized with colour coding, which has helped Element Six to show chemical and abrasive wear of the tool. Matthew Goulbourn-Lay points out: “We have also used surface mapping across large diamond discs which have been worn in their specific application. Understanding the depth and map of the wear has been incredibly useful.”

Evaluating the total volume of worn and accumulated material

In a second stage, Element Six compares the three-dimensional structure of the tools before and after their usage to determine important parameters, such as the total volume of worn and accumulated material. Measured parameters include crater depth and volume, the maximum and mean defect across the clearance surface, flank wear as well as the notch wear. This gives information about the contact between the edge and the workpiece during the cutting process. Matthew Goulbourn-Lay explains: “In order to test how each new development material is wearing, we compare the wear scars of different materials. The various measurements and visualization taken allow us to build a better picture of how a specific tool material wears over time. This has led to numerous material developments in both PCBN and PCD materials research.”



“In order to test how each new development material is wearing, we compare the wear scars of different materials. The various measurements and visualization allow us to build a better picture of how a specific tool material wears over time.”

3D measurement of a cutting tool insert in true colour.
Element Six compares the 3D structure of the tools before and after their usage to determine important parameters, such as the total volume of worn and accumulated material.

Goulbourn-Lay and his team were impressed with the flexibility of the measurement system and range of different measurement options available, providing the ideal solution for the R&D environment. After using the InfiniteFocus G4 system for many years and having upgraded it, the Element Six decided in 2016 to invest in a second Alicona solution, the successor InfiniteFocus G5 system. “We wanted the same software that our people knew and that was easy to handle. Repeatability is important for our quality control process and we appreciate the systems’ flexibility in use and abilities”, Golbourn-Lay concludes.

elementsix™
a De Beers Group Company

"Thanks to the repeatable measurements by Alicona we have managed to strike the perfect balance between efficiency and quality in the machining of PCD cutting edges."

Arndt Hauger, Product Manager Hybrid Processing, Germany: "Our customers profit immensely from our ability to measure the geometry, edge radius, angles and surface of PCD cutting tools after machining. It enables us to provide our clients with a more reliable and consistent service. Thanks to the optimum machine parameters for the new Vpulse eroding generator, we are now able to machine PCD tools 30 % faster, possible surface quality has improved by a factor of two and above."

VOLLMER

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PCD tools—optimum balance between efficiency and quality

Vollmer is a manufacturer of sharpening and eroding machines for use in tool production and maintenance. To be able to machine state-of-the-art PCD tools, Vollmer developed the new Vpulse eroding generator. Before implementing this new machine, it was necessary to work out the ideal erosion parameters to ensure quality, precision, and efficiency. Vollmer accomplishes this by measuring finished tools with Alicona measurement systems. The world market leader particularly profits from Alicona's solutions for high-resolution 3D surface measurements and precise, repeatable edge-preparation measurements with close tolerances.

PCD is an extremely hard matrix of synthetically created diamond particles that is becoming increasingly relevant in the manufacturing of cutting tools. "In the machining of highly abrasive light-weight materials, cutting edges made from polycrystalline diamond provide customers with significantly longer tool lives compared to carbide cutting tools and ensure more precise machining of plastic, aluminum, magnesium, and wood," says Arndt Hauger, giving an insight into the world of PCD manufacturing.

Electrical discharge machining has the advantage of permitting highly precise sharpening of cutting edges. This method works by using electrical currents to generate discharges, which then remove microscopic amounts of material from a workpiece. The edge rounding of PCD tools, the proper edge preparation of the cutting edge is critical. It is this quality that determines the quality and service life of a tool.

Faced with the challenge to erode PCD tools in an optimal quality, Vollmer was in need of a flexible measurement system capable of robust and repeatable measurements to verify edges, clearance surface and chipping. With Alicona, Vollmer now has a way of accurately inspecting the before mentioned quality characteristics and, consequently, identifying the ideal machining parameters for the Vpulse eroding generator. Vollmer's customers in turn profit from highest precision and reliability in the eroding of PCD tools. "Thanks to the repeatable measurements by Alicona we have managed to strike the perfect balance between efficiency and quality in the machining of PCD cutting edges", product manager Arndt Hauger reports. Vollmer carries out measurements on finished PCD tools in order to identify optimum machine parameters. The InfiniteFocus system is used to achieve repeatable high-resolution measurements of the topography and geometry of a tool's clearance surface.

Examining clearance surfaces by measuring roughness

Secondarily a tools clearance surface determines a workpieces roughness, as it influences the chipping along the cutting edge. Alicona's 3D areal surface-texture measurement allows Vollmer to verify the roughness of the entire clearance surface, even of its curved parts. Measured values include profile-roughness parameters (Ra, Rz), areal parameters (Sa, Sz), volume parameters, and bearing area curve. True-color 3D surface visualization makes it easy to identify burns or impurities. Focus-Variation provides true-color information for any point of measurement. "The true-color pictures make it possible to quickly assess the results," Arndt Hauger confirms.

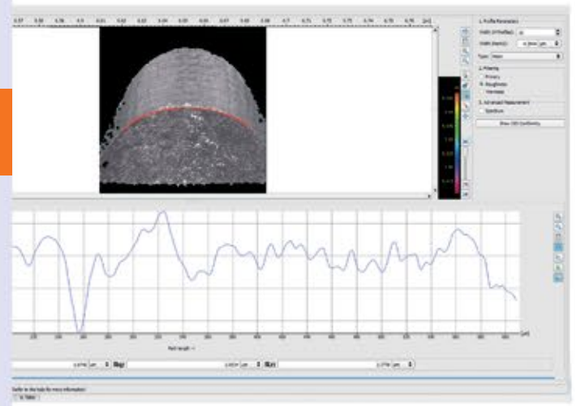
Assessment of cutting edge quality

Aside from inspecting the surface texture of the clearance surface, Vollmer also measures the geometry of the cutting edge with Alicona systems to check for cracks. "The main measurement parameters are radius, wedge angle, and chipping," Arndt Hauger explains. Vollmer uses Alicona's Chipping Module to identify chipping on the cutting edge. Other form deviations can be assessed using 3D difference measurement. This consists of comparing the edge's geometry to an imported CAD dataset or reference geometry in a fully automatic process. Form deviations are detected automatically and visualized using a special color coding.

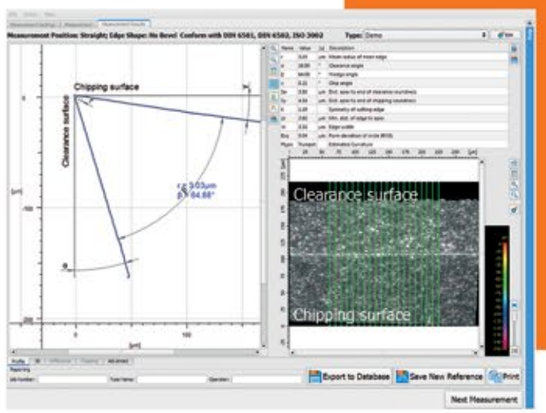
With InfiniteFocus, the following parameters of PCD cutting edges are measured:

- *roughness of the clearance surface (Ra, Rz, Sa, Sz)*
- *volume*
- *bearing area curve*
- *chipping*
- *form deviations to CAD dataset*

3D surface texture measurement: roughness verification over the entire clearance surface. Identification of height differences with 3D visualization based on real color information.



Chipping measurement along the edge to improve edge stability



Radius and form measurement of edge rounding up to 3 µm to increase tool quality and service life

“Alicona enables us to gain new knowledge on the reproducibility of our manufacturing processes.”

Uhlmann

Optical measurements during serial production in the pharmaceutical industry

Product safety is particularly important in the production of pharmaceutical packaging and is subject to stringent requirements. Uhlmann – experts in the field of pharmaceutical packaging – use Alicona to verify the quality of machine components, thus gaining knowledge on the reproducibility of manufacturing processes.

Pharmaceutical packaging must be optimally sealed to prevent foreign substances from entering and it must also follow all legal guidelines on counterfeit protection and traceability. When it comes to the production of pharmaceutical packaging, priority is given to the protection of the high-quality ingredients and formulations while maintaining complete functionality.

Based in Germany, Uhlmann Pac-Systeme GmbH & Co. KG is one of the world’s leading suppliers of pharmaceutical packaging. Uhlmann’s product portfolio includes machines for all process steps: from blister machines and bottling lines to cartoners and end-of-line packaging machines. This range is complemented by extensive services for the systems’ entire life cycle.

New knowledge on the reproducibility of manufacturing processes

When manufacturing special pharmaceutical machines, the focus is to implement professional quality assurance processes at all stages of production. Uhlmann use the high-resolution measurement system InfiniteFocus to test the machine components and the packaging products they fabricate. “Alicona allows us to gain new knowledge on the reproducibility of our manufacturing processes. Besides this, the measurements also enable us to verify supplier specifications for purchased parts, predict the functional behaviour of products and carry out cause analyses on the functionality of products”, says Matthias Obert, member of Uhlmann’s Quality Management team.

Uhlmann, specialists in the field of pharmaceutical packaging, use Alicona for monitoring measurements during the manufacturing process of blister machines.

Monitoring measurements in the manufacturing process of blister machines

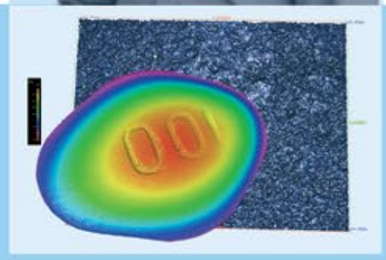
Obert explains the process monitoring during serial production, using the manufactured blister machines as an example. “We use Alicona to carry out monitoring measurements in the manufacturing process and to verify the geometry and surface properties of individual components.” Blister machines are used to produce blister packaging, better known as “blister packs”. These packs contain the pre-sorted medicine and are hygienically sealed using plastic or aluminium composite foils. Each separate drug unit has its own “cup”, from which the tablet or capsule can be popped out with your fingers.

Material parameters for the evaluation of the functional surface behaviour

The process steps of a blister packaging machine include, first and foremost, the shaping of the cup-shaped depressions into the base, which is made of aluminium foil. The product, tablets or capsules, are then filled into the cups. In a next step, a cover film is fed through the sealing station and placed on the base foil. The cover film is warmed up by means of hot plates to enable it to mould to the base foil, thus enclosing the product in the cup-shaped depression. In order to prevent sticking to the hot plates and to ensure optimum heat distribution on the hot plates, Uhlmann implement the measuring system to determine surface parameters (Sa, Sz) and material parameters (Sk, Spk). Obert:”Surfaces with similar Sa values can have completely different structures. Often, one can only provide a sound statement about the functional behaviour of the surface after evaluating the material ratio parameters.”

Sealing rollers made of tool-grade steel or high-quality aluminium are used for bonding the film to the foil. The contact surfaces of the rollers have inclined surfaces and tips, i.e. pyramid-shaped corrugation. The distribution density of these “pyramids” dictates how deep the tips penetrate in the foil composite and thus provides a contact face adapted to the surface pressing requirements. “Before we switched to the measuring technology of Alicona, we could not measure these corrugated geometries. The analysis of the pyramid stump dimensions, such as the angle, height and distance to each other, gives us indispensable information.” Once the sheet is sealed air-tight, each tablet is enclosed by two longitudinal sealing gutters and two transverse sealing gutters. The seal shape of the blisters is checked in the course of the packaging process. The shape measurement and color evaluation enable Uhlmann to check the homogeneity of the impression and lacks gutter width and height.

After sealing the carrier foil and cover film, it is possible to emboss specific safety features (e.g. batch number) permanently on the blister reel. The serial numbers are punched in using die stamps. Uhlmann use InfiniteFocus to ensure the correct letter height of the die stamp, measure the surface roughness and perform a visual inspection.



3D pill measurement. Uhlmann use optical measurements to gain information on the slide characteristics of pills and capsules.

“It was only with Alicona that we could measure specific corrugated geometries of our machine components.”

Matthias Obert,
Quality Management at Uhlmann

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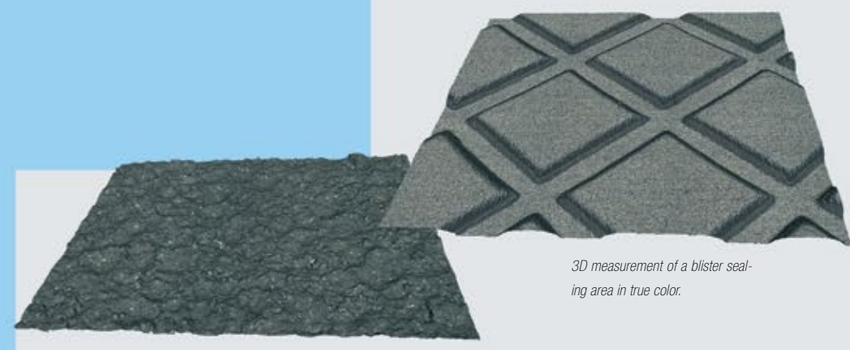
Simple handling and extensive applicability

The cut areas of the punched blister packages are then evaluated. „About Alicona, we particularly appreciate the ease of use of the system and its extensive applicability. The color-coded height representation comes in very helpful to communicate surface properties easily and intelligibly to other interfaces in the company“, explains Obert.

In order to ensure the quality of the production process of the blister machines, Uhlmann also require information on the slip properties of the tablets and capsules. To do this, one needs to know the surface roughness of the medicine. Tactile measuring methods are not suitable for this application because the surface of the measuring object can alter or get damaged in direct contact with the medicine. Alicona helps determine surface characteristics of the tablets (e.g. Sa and Sz) without touching the surface.



3D measurement of a blister sealing area in true color.

3D measurement of the hot plate surface in true color. The hot plates warm up the cover film before sealing it onto the base foil. Alicona enables Uhlmann to determine extensive surface parameters (Sa, Sz) and material parameters (Sk, Spk).

”Alicona helps to secure our quality leadership.”

Optiprint
innovative PCB Solutions

Reliable quality assurance of printed circuit boards

Optiprint is a supplier of highly innovative printed circuit boards for use in medical engineering, the automotive and sensor industries, and space engineering. When the company was probing the market for a non-contact, areal surface measurement system, Alicona‘s 3D measurement systems attracted its attention. Optiprint now relies on InfiniteFocusSL in the quality assurance of printed circuit boards. The solution by Alicona allows Optiprint to measure form and roughness of complex, miniaturized component surfaces with just one system.

Today‘s printed circuit boards are carriers for simple to highly complex electronic. For 30 years now, Optiprint in Berneck (Eastern Switzerland) has been producing highly innovative circuit boards solutions. New high-performance materials and more efficient ways of assembly, such as the Chip-on-Board technology, are becoming increasingly relevant. In light of these challenges, Optiprint was in need of a system for areal topography and flatness measurement of so-called chip pockets. ”Alicona‘s 3D measurement system have allowed us to optimize our processes significantly and take major steps in securing the quality leadership of our products,“ quality manager Simon Hütter explains. The 3D measurement solutions provided by Alicona have made it possible for customers of Optiprint to ensure flawless chip bonding (attaching of the chips) and wire bonding (attaching wires to connect chip and circuit board carrier).

Microvias: optical 3D measurement of diameter and depth

Optiprint’s quality assurance puts great emphasis on providing printed circuit boards that are well-suited to further processing by customers. In order to ensure proper electrical connection of multi-layered circuit boards, it is vital that the so-called microvias have been drilled according to pre-defined depth and diameter parameters. Alicona‘s measurement systems allow Optiprint to verify diameter and height step of the microvias to confirm that the correct layers have been connected.

Another type of measurement of laser-dilled microvias is checking for traces of powder. Traces of powder form at the outer edge of laser drill holes when molten material lumps together. With optimized laser parameters for the different materials these bulges are minimized. To identify bulges, the planarity at the transition of the surface to the microvia is carried out with roughness measurements by Alicona systems.

Apart from the above-mentioned measurements of depth, diameter, and planarity, microvia bottoms also need to be examined during quality assurance. The most critical fault to check for here is residual insulating material, as this can impede the electrical conductivity of the entire circuit board. It is therefore essential to verify that this area of the microvia is clean before further processing. Optiprint accomplishes this with Alicona‘s high-resolution true-color 3D visualization systems.

Chip pockets: Area based measurement of shape and flatness

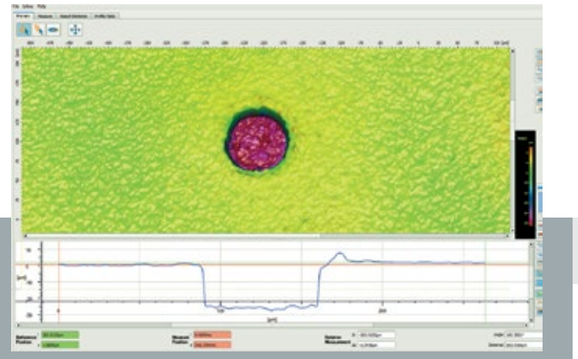
As the next step of the production process, chip pockets are milled into the circuit board to make room for the chips the end customer will later attach to the circuit board. Attaching the chips to the milled pockets is also called Chip-on-Board technology. In order for the silicium chips to remain in place securely, the milled pockets must have the correct shape and be flat. Thanks to Alicona’s roughness measurement system, Optiprint has managed to gain a better understanding of the interaction between surface properties and assembly process. This in turn has resulted in a much more efficient manufacturing process. In order to ensure proper surface quality and, consequently, flawless attaching, Optiprint measures the height steps as well as shape and flatness of the chip pockets. ”Only when we started using areal roughness measurement was it that we mastered the process for milled pockets,“ says Simon Hütter.

3D profile form measurement of bondpads

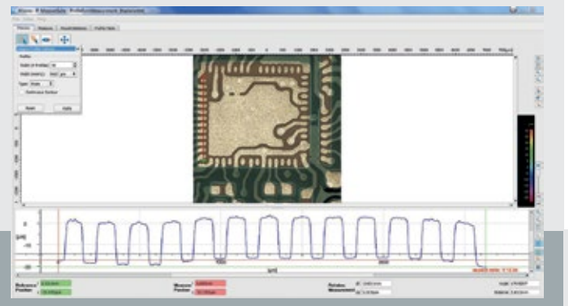
Another step in the manufacturing process is the electrical bonding (interconnecting) of the Chips on Board. The electrical interconnecting of chips with the circuit board with using the so-called bond wires is also called wire bonding. Bondpads must be free of faults such as roughness and dirt, as these weaken the bond interconnection. Alicona‘s 3D profile measurement system enables Optiprint to verify the form and co-planarity of contact pads on the printed circuit board and ensure perfect conditions for wire bonding.

The following parameters of multi-layer circuit boards can be measured and documented precisely with 3D measurement systems by Alicona:

- Depth and diameter of microvias
- Areal roughness at the transition of surface to drill hole
- Areal roughness and flatness at the bottom of microvias
- Areal topography and roughness of milled pockets (chip pockets)
- 3D profile form of bondpads
- Analysis and rating of quality characteristics



Area based roughness measurement of the microvia to identify traces of powder



3D measurement of shape an co-planarity of contact pads to ensure perfect conditions for wire bonding

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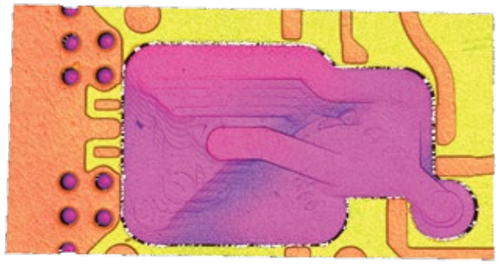
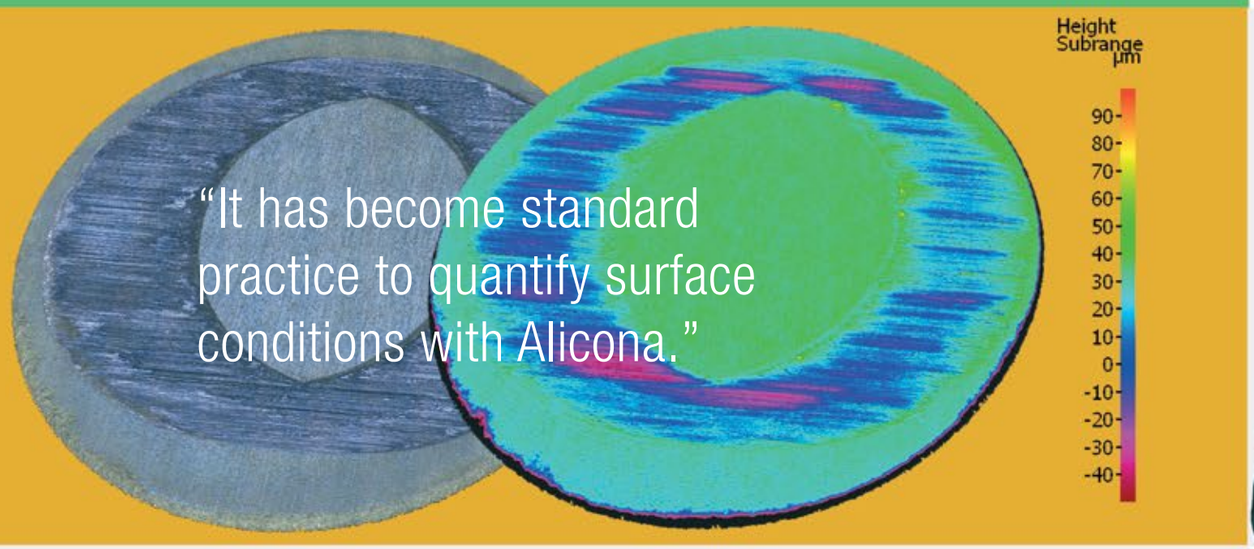
Simon Hütter
Quality Manager
Optiprint AG, Berneck (CH)

”Our customers use printed circuit boards by Optiprint to manufacture products of the highest quality. Alicona‘s customized 3D measurement solutions play a key role in enabling us to provide our customers with the exceptional quality they need. Their systems contribute significantly to our company’s success. We can only recommend Alicona to everyone.“

Simon Hütter, Quality Manager



3D visualization of the chip pocket before surface finish. The visualization has helped to optimize the Chip-on-Board technology. Optiprint has managed to gain a better understanding of the interaction between surface properties and assembly process.

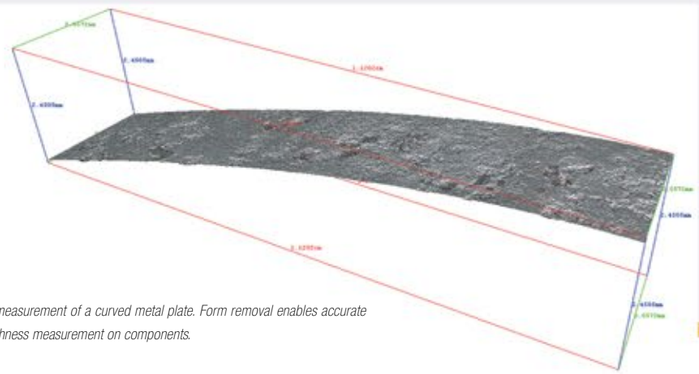


"It has become standard practice to quantify surface conditions with Alicona."

Materials in shape

Materials science deals with the correlation between a material's surface and its mechanical properties. Properties such as fatigue, wear, and corrosive resistance are highly dependent on the microstructure of components. The National University of Malaysia uses Alicona's InfiniteFocus measurement system to measure the size, shape and texture of various materials. These measurements help determine which surface features effect which material characteristics.

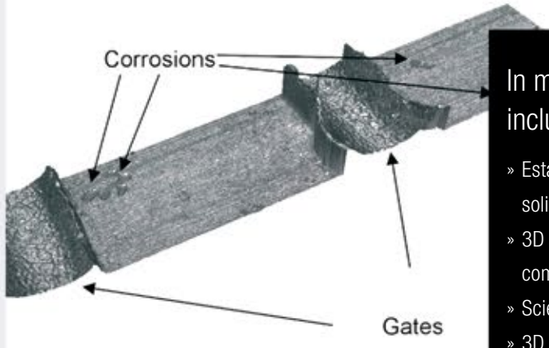
At the Institute of Microengineering and Nanoelectronics (IMEN) at the National University of Malaysia, scientists are particularly interested in correlating surface structure to performance. Their research focuses on using size, shape, and texture of surface features on a variety of solid materials such as metals, semiconductors, ceramics, polymer, composites, and metal alloys to extrapolate properties such as stress, fatigue, wear resistance, and corrosivity in order to design new more resilient materials. Previously, the research was limited to use of confocal microscopes or profilometers, but Alicona's InfiniteFocus measurement device enables more complete material surface characterization. IMEN Deputy Director and Senior Research Fellow Azman Jalar is excited by the increased surface analysis capabilities in the materials research laboratory: "Before I worked with Alicona, I struggled with my analysis tools. Neither my confocal microscope nor the 2D profilometer could adequately measure polished metal surfaces or silicon wafers. With our InfiniteFocus system, I have a reliable surface quantification tool that perfectly suits my research area. In our lab, it has become standard practice to quantify surface characteristics with Alicona's Focus-Variation."



3D measurement of a curved metal plate. Form removal enables accurate roughness measurement on components.

Understanding corrosion fatigue

While the research at IMEN is broad, one of the key capabilities of the InfiniteFocus system is roughness measurements. The Alicona system provides profile based roughness measurement (Ra, Rq, Rz) and surface texture (Sa, Sq, Sz) measurements. This is accomplished by areal measurement, bearing area curve, and fractal dimension analysis. These measurements allow a more complete understanding of the functionality of the surface and quantitative corrosion or defect analysis. While other technologies only perform a 2D classification of corroded regions, InfiniteFocus relies on 3D information for corrosion detection and analysis. Corrosion measurements are quick and easy as the system is especially designed for corrosion analysis over large scan areas up to 200 x 200 mm. The system's high resolution and traceable and highly repeatable measurement give IMEN the confidence to correlate surface structure with a material´s properties. In addition, the Alicona data is a true color visualization of the measured surface to allow easy identification and confirmation of corrosion or defects on a material's surface. The design of the InfiniteFocus system allows it to be applicable for a wide range of sample sizes, materials, and surface condition. "We investigate a variety of sample shapes and sizes including components with cylindrical or arbitrary form. For example, to measure our curved metal plates, I can easily acquire a high-resolution 3D dataset and then remove the form to accurately analyze surface structure detail independently," says Azman Jalar about the flexible use of his InfiniteFocus system. Advanced corrosion investigations can be performed on materials of various surface finishes and compositions such as stainless steel, nickel-based alloys, titanium, or aluminum alloys.



3D measurement of a corroded aluminum plate, also showing channels. Users can perform automatic defect detection.

"With Alicona, I have a powerful measurement tool for research investigations in materials science. It allows me to extrapolate which surface feature of my material causes which behavior. The measurement device is applicable to all materials in my research area including metals, semiconductors, ceramics, polymer, composites, and metal alloys. It is also highly intuitive to use and does not require high training effort."

Dr. Azman Jalar,
Deputy Director of Institute of Microengineering and Nanoelectronics, National University of Malaysia.

Universiti Kebangsaan Malaysia
The National University of Malaysia

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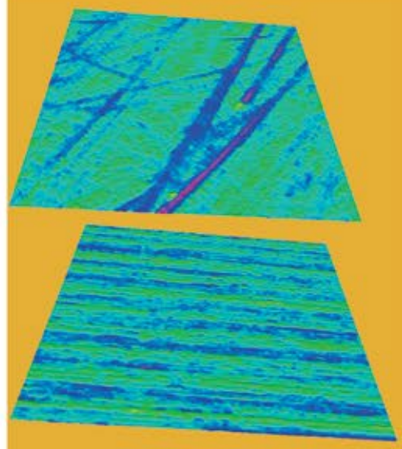
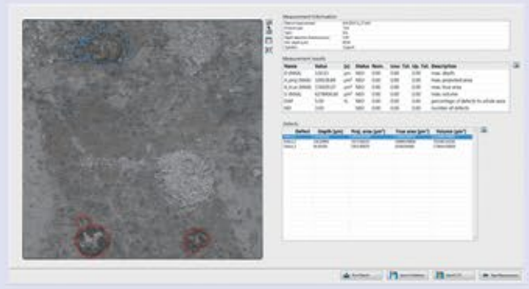


3D surface measurement of a honed surface (above, Svk: 0.38 µm) and a ground surface (below, Svk: 0.2 µm) in pseudo-color. The areal volume parameter Svk describes height differences. Here, it indicates the higher surface quality of the grinded tool.



Automated corrosion detection with InfiniteFocus. Parameters of all defects are tabulated.

In materials science, Alicona systems can be used in many ways including the following:

- Establish a correlation between surface parameters and functional behavior of solid materials
- 3D surface measurement of metals, semiconductors, ceramics, polymer, composites, and metal alloys
- Scientific research in corrosion, tribology, fracturing, etc.
- 3D measurement of profile roughness, surface texture measurement, and volume measurement including fractal dimension and bearing area curve

“With Alicona we found an all-in-one measurement system for the analysis of the most diverse materials and components.”

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An all-in-one measurement solution for materials of any kind

In their research on materials, Tampere University of Technology in Finland explores innovative approaches for a variety of technical applications. With Alicona they have found an all-round tool for the analysis of the most diverse materials and the geometrical verification of a multitude of components with different shapes and sizes.

The material selection is a key factor in the production of high-quality technical components. Technical innovations and new manufacturing processes are directly tied to the research and development of materials. Wear resistance, corrosion resistance and service life of components are determined by correct material selection for the target application.

Evaluation of surface deformation, wear intensities and mechanisms

The Laboratory of Materials Science at Tampere University of Technology (TUT) in Tampere, Finland, conducts high-level research on the structure, properties, processing and use of practically any type of material. With the optical 3D measurement system InfiniteFocus G5 they analyze the morphology of surfaces, verify dimensioning, and evaluate surface deformations, wear intensities and mechanisms. In strong collaboration with the industry, a broad variety of technical applications is covered. Measured materials include metals, polymers, textiles, wood, paper, ceramics, coatings and rocks. In addition, the optical 3D measurement system is used for full form measurement of various tools and components.

Since components in materials testing often contain fractured or deformed surfaces, steep flanks or rough surface topographies are regularly encountered. Alicona offers a unique solution to document the entire surface even with these difficult to measure features. “Initially, we were looking for a system that could measure specimens with both large areas of several square centimeters width and rough surfaces, like large wear or fracture surfaces with steep slopes. For us it was also important that the measurement system would be relatively fast. A third requirement was the possibility to do measurements by rotating the specimen and have real 3D datasets as a result”, Niko Ojala and Jarmo Laakso, researchers at the laboratory, explain. “With InfiniteFocus we have found a measurement system that suits our needs. Due to the high demand and interest towards the system, the utilization ratio has been up to 24/7.”

Geometric verification of FSW tools for sealing nuclear fuel disposal canisters

The Applied Materials Science research group at the laboratory offers service for companies in any type of material related projects. “In collaboration with two Scandinavian expert organizations for nuclear waste management, SKB and Posiva Oy, we were able to verify the geometry of a FSW-probe, which is used for sealing nuclear fuel disposal canisters”, Jarmo points out. FSW (Friction Stir Welding) is a welding method in which frictional heat is generated between the tool and a target metal. This causes the metal to soften and weld together by mechanical intermixing. The probe is intended to be non-consumable, so the challenge is to prevent the probe material from melting, while it is traversed along the welding line. Thus, the accurate geometry of it is a key factor for an efficient welding process. With an AdvancedReal3D Rotation Unit in addition to InfiniteFocus they achieve full form measurements of tools and components. This enabled Jarmo to measure dimensions like length, diameter and radius, as well as roundness. Radii can be measured down to 2 µm in lateral resolution. The measurements show if components are in accordance to the specified tolerances. Form deviations are evaluated by comparison to CAD data.

“Previously we only had an interferometry system, but it was not able to measure large areas efficiently, in fact it would have needed days to do that. With Alicona we measure areas up to 200 x 200 mm at high measurement speed”, Niko and Jarmo explain. As measurements of large areas often also require long measurement depth z-ranges – as components can either have a curved form, large height differences or highly deformed surface – InfiniteFocus has proven to be the right tool.

Easy quantification of material deformation on large measurement areas

By using the so called MultiMeasurement function, Niko and Jarmo found a feature that has proven to be very time-saving. “With MultiMeasurement we can set up an automatic measurement routine for about a dozen of specimens to be measured one after another or measure multiple locations in high-resolution. This saves both working and machine time for other tasks as for example night times can be fully utilized”, explains Niko. “Versatility and agility are important, as well as user friendliness, and that’s what Alicona gives us.”

Niko Ojala, *researcher at the Laboratory of Materials Science at TUT; using MultiMeasurement: With InfiniteFocus G5 Ojala defines the measuring routine with which several specimens are automatically measured one after another.*

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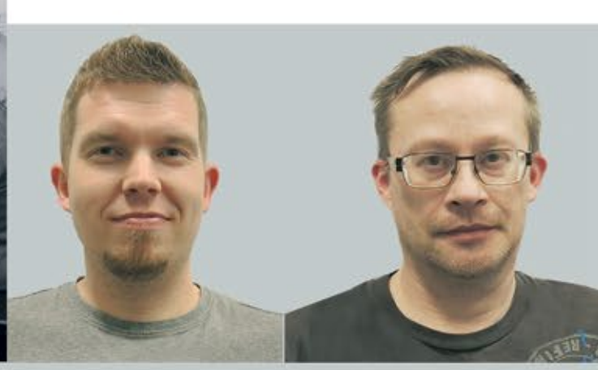
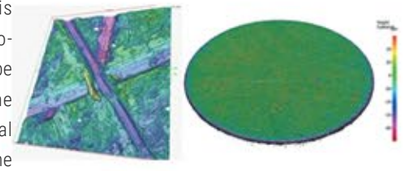
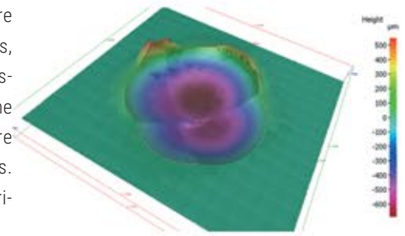


Niko Ojala, *and* ***Jarmo Laakso,*** *Tampere University of Technology, Laboratory of Materials Science:*
“Before Alicona we only had an interferometry system, but it was not possible to measure large areas efficiently, in fact it would have needed days to do that.”

“Full form measurement of a FSW-probe of SKB and Posiva Oy. With an AdvancedReal3D Rotation Unit in addition to InfiniteFocus the full form measurement is achieved.(© SKB and Posiva Oy, not allowed to copy without permission)”



Crushing pin-on-disk high-stress abrasion wear test: The Alicona measurement system provides numerical quantification and a detailed 3D surface characterization of the specimens both in full macro and detailed micro levels. (picture on left has surface area of about 3 mm2, while the one on right covers 1 000 mm2 area)



3D surface measurement of a steel specimen after five impacts by the high velocity particle impact test at -60°C temperature.

TAMPERE UNIVERSITY OF TECHNOLOGY

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THE FORUM

Need help with a new measurement task?

Check out the forum and the FAQs if your question has already been answered or ask the community for further help. Share and discuss your experiences - that's what the Alicona family is for.

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Enjoy the video section demonstrating metrology using Focus-Variation and explore the library including scientifc papers dealing with metrology.

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Use the opportunity to participate in Alicona's development process and design your future products.

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Getting an insight in Aliconas daily life

Enjoy stories about the company, the staff, events and more.

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And a personal note.

To tell you the truth, I did not believe that they would be finished on time, these more than 100 pages of the 7th edition of FOCUSvariation. I know, I say this every time, it is something one sort of has to say in regard to publishing and keeping an unnegotiable and hard deadline. However, this time…
But then, we managed. It is thanks to a powerful team that kept on going with me to finally get this magazine into print. Also, the people working with me on this issue inspired me to come up with new ideas and topics, resulting in a magazine that has not only grown in its number of pages.
I would like to say thanks to all those who participated and take the opportunity to introduce at least some of the team members.

Special credits go to

Katharina	who did not only manage all new user case stories. Thanks for your invaluable support and commitment!
Olivia	who is unbeatable in terms of technical specifications
Michael	who has contributed to a new dynamic in the way we describe features and benefits of Focus-Variation
Julia	when things are at a push, you star in staying calm and just doing things!
Angelika and Ulli	who have made sure that we also have an English version
and Herbert	I hope not all your customers are like me…! Thank you for your patience and endurance

Alicona workshops

An Alicona workshop at your site?

Contact us – we look forward to optimizing your precision manufacturing through optical 3D metrology.

DANIEL GROSSMANN
BUSINESS DEVELOPMENT
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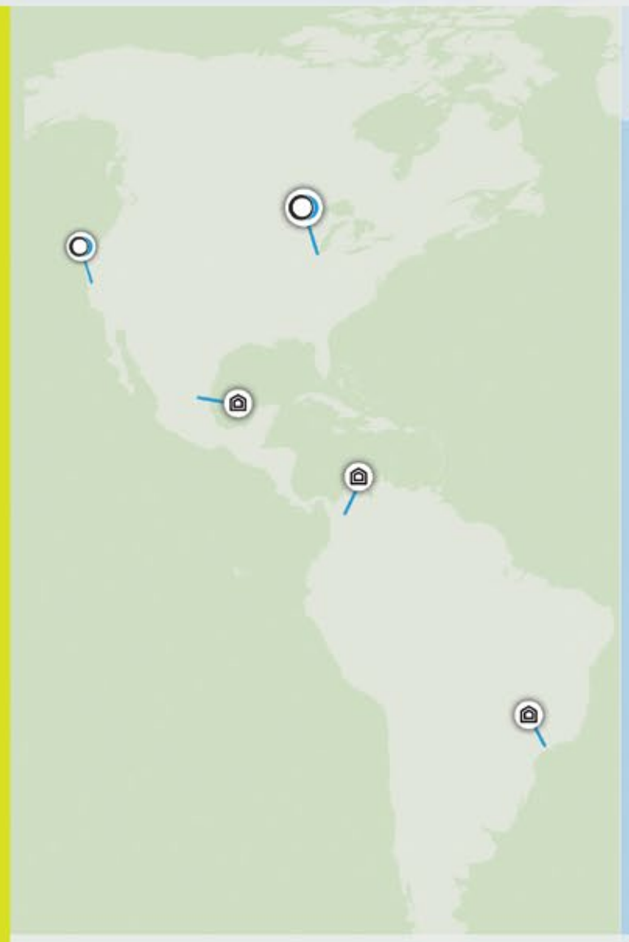
Alicona worldwide



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Measuring systems

technical specifications

InfiniteFocus G5

Optical micro coordinate measurement and surface finish measurements in one system

InfiniteFocus is a highly accurate, fast and flexible optical 3D measurement system. Users benefit from a 3D micro coordinate measurement machine and surface roughness measurement device combined in one system. The range of measurable surfaces is almost unlimited. All relevant surface features of micro precision components are measured using only one multifunctional measurement sensor. Users achieve traceable measurement results in a high repeatability and a vertical resolution of up to 10nm. The robust measurement principle of Focus-Variation in combination with a vibration-isolating hardware enables the form and roughness measurement of also large and heavy components. All axes of InfiniteFocus are equipped with highly accurate encoders ensuring precise stage movement. With an automation interface, InfiniteFocus is also applied for fully automatic measurement in production.

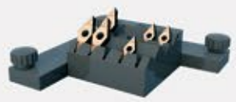
AdvancedReal3D RotationUnit G2

Real3D Rotation Unit G2

RotationGrip

RinglightHP

AdvancedInsertGrip



InsertGrip G2

ToolGrip

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GENERAL SPECIFICATIONS

Positioning volume (X x Y x Z)	100 mm x 100 mm x 100 mm = 1000000 mm^3 200 mm x 200 mm x 100 mm = 4000000 mm^3 200 mm x 200 mm x 200 mm = 8000000 mm^3
Max. specimen weight	30 kg; more on request

OBJECTIVE SPECIFIC FEATURES

Objective magnification (*)		**2.5x**	**5x**	**10x HX (**)**	**10x**	**20x HX(**)**	**20x**	**50x**	**100x**
Numerical aperture		0.075	0.15	0.2	0.3	0.3	0.4	0.6	0.8
Working distance	mm	8.8	23.5	37	17.5	30	19.0	11	4.5
Lateral measurement range (X,Y) (X x Y)	mm	5.63	2.82	1.62	1.62	0.7	0.81	0.32	0.16
	mm^2	31.7	7.95	2.62	2.62	0.49	0.66	0.10	0.03
Extended lateral measurement range (X x Y)	mm^2	6195.26	1548.42	387.30	387.30	96.83	96.83	15.49	3.87
Measurement point distance	µm	3.52	1.76	0.88	0.88	0.44	0.44	0.18	0.09
Calculated lateral optical limiting resolution	µm	4.35	2.18	1.64	1.09	1.09	0.82	0.54	0.41
Finest lateral topographic resolution	µm	7.04	3.51	1.76	1.76	1.17	0.88	0.64	0.44
Measurement noise	nm	800	120	75	30	20	10	3	1
Vertical resolution	nm	2300	410	250	100	80	50	20	10
Vertical measurement range	mm	8	22.5	36	16.5	29	18	10	4
Vertical scanning speed	µm/s	3000	3000	1000 - 3000	1000 - 3000	500 - 3000	500 - 3000	200 - 2000	100 - 1000
Measurement speed	≤ 1.7 million measurement points/sec.								

(*) Objectives with longer working distance available upon request (**) Objective available in special objective configuration
(***) Larger measurement areas possible with data reduction (primarily limited by positioning volume)

RESOLUTION AND APPLICATION SPECIFICATIONS

Objective magnification		**2.5x**	**5x**	**10x HX**	**10x**	**20x HX**	**20x**	**50x**	**100x**
Min. measurable height	µm	2.3	0.41	0.25	0.1	0.08	0.05	0.02	0.01
Max. measurable height	mm	8	22.5	36	16.5	29	18	10	4
Height step accuracy (1 mm)	%	n.a.	0.05	0.05	0.05	0.05	0.05	0.05	0.05
Max. measurable area Optional	mm^2	10000 40000	10000 40000	10000 40000	10000 40000	10000 24780	10000 24780	3965 3965	990 990
Max. measurable profile length Optional	mm	100 200							
Min. measurable roughness (Ra)	µm	7	1.2	0.75	0.3	0.24	0.15	0.06	0.03
Min. measurable roughness (Sa)	µm	3.5	0.6	0.375	0.15	0.12	0.075	0.03	0.015
Min. measurable radius	µm	20	10	5	5	3	3	2	1
Min. measurable wedge angle	°	20							
Max. measurable slope angle	°	87							

ACCURACY

Flatness deviation	1.6 mm x 1.6 mm with 10x objective	U = 0.1 µm
Max. deviation of a height stepmeasurement	height step 10000µm height step 1000µm height step 100µm height step 10µm height step 1µm	$E_{Uni: St: ODS, MPE}$ = 0.8 µm, σ = 0.4 µm $E_{Uni: St: ODS, MPE}$ = 0.5 µm, σ = 0.1 µm $E_{Uni: St: ODS, MPE}$ = 0.4 µm, σ = 0.05 µm $E_{Uni: St: ODS, MPE}$ = 0.3 µm, σ = 0.025 µm $E_{Uni: St: ODS, MPE}$ = 0.15 µm, σ = 0.01 µm
Profile roughness	Ra = 0.1 µm Ra = 0.5 µm	U = 0.025 µm, σ = 0.002 µm U = 0.04 µm, σ = 0.002 µm
Area roughness	Sa = 0.1 µm Sa = 0.5 µm	U = 0.02 µm, σ = 0.002 µm U = 0.03 µm, σ = 0.002 µm
Distance measurement	XY up to 1 mm XY up to 10 mm XY up to 20 mm	$E_{Bi: Tr: ODS, MPE}$ = 0.7 µm $E_{Bi: Tr: ODS, MPE}$ = 1.0 µm $E_{Bi: Tr: ODS, MPE}$ = 2.0 µm
Wedge angle	β = 70 ° - 110 °	U = 0.15 ° , σ = 0.02 °
Edge radius	R = 5 µm - 20 µm R > 20 µm	U = 1.5 µm, σ = 0.15 µm U = 2 µm, σ = 0.3 µm

$E_{Uni: St: ODS, MPE}$ & $E_{Bi: Tr: ODS, MPE}$ conform to ISO 10360-8

Initiative Fair Data Sheet
Specifications in blue mark Alicona specific values.

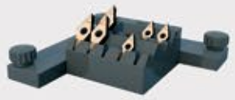
InfiniteFocusSL

As fast and intuitive as 3D surface measurement can be

InfiniteFocusSL is a cost efficient optical 3D measurement system for easy, fast and traceable measurement of form and finish on micro structured surfaces. Users measure both form and roughness of components with only one system. In addition, color images with high contrast and depth of focus are achieved. The long working distance of up to 33mm in combination with its measurement field of 50mm x 50mm allows a wide range of applications. Measurements are achieved in seconds and features, such as a coaxial laser for quick and easy focusing, further increase usability. With an automation interface, InfiniteFocusSL is also applied for fully automatic measurement in production.

Real3D Rotation Unit G2

AdvancedInsertGrip



InsertGrip G2

ToolGrip

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GENERAL SPECIFICATIONS

Positioning volume (X x Y x Z)	RL objectives: mot.: 50 mm x 50 mm x 155 mm (Z: 25 mm mot., 130 mm man.) = 387500 mm³ SXRL/AXRL objectives: mot.: 50 mm x 50 mm x 120 mm (Z: 25 mm mot., 95 mm man.) = 300000 mm³
Max. specimen weight	4 kg; more on request

OBJECTIVE SPECIFIC FEATURES

Objective magnification (*)		**10x**	**20x**	**50x**	**2xSX**	**5xAX**	**10xAX**	**20xAX**	**50xSX**
Numerical aperture		0.3	0.4	0.6	0.055	0.14	0.28	0.42	0.55
Working distance	mm	17.5	16	10.1	34	34	33.5	20	13
Lateral measurement area (X,Y) **(X x Y)**	mm mm²	2 4	1 1	0.4 0.16	10 100	3.61 13.03	2 4	1 1	0.4 0.16
Ext. lat. measurement area (X,Y) **(X x Y)**	mm mm²	50 2500							
Measurement point distance	µm	1	0.5	0.2	5	2	1	0.5	0.2
Calculated lateral optical limiting resolution	µm	1.09	0.82	0.54	5.93	2.33	1.17	0.78	0.59
Finest lateral topographic resolution	µm	2	1	0.64	10	4	2	1	0.64
Measurement noise	nm	40	20	10	1240	165	45	25	15
Vertical resolution	nm	100	50	20	3500	460	130	70	45
Vertical measurement range	mm	16	15	9	25	25	25	19	12
Measurement speed	≤ 1.7 million measurement points/sec.								
Accessibility	°	31	29	19	40	51	51	39	26

(*) Objectives with longer working distance available upon request

RESOLUTION AND APPLICATION SPECIFICATIONS

Objective magnification		**10x**	**20x**	**50x**	**2xSX**	**5xAX**	**10xAX**	**20xAX**	**50SX**
Min. measurable height	nm	100	50	20	3500	460	130	70	45
Max. measurable height	mm	16	15	9	25	25	25	19	12
Height step accuracy (1 mm)	%	0.1							
Max. measurable area	mm²	2500							
Max. measurable profile length	mm	50							
Min. measurable roughness (Ra)	µm	0.3	0.15	0.08	n.a.	n.a.	0.45	0.25	0.15
Min. measurable roughness (Sa)	µm	0.15	0.075	0.05	n.a.	n.a	0.25	0.1	0.08
Min. measurable radius	µm	5	3	2	20	10	5	3	2
Min. measurable wedge angle	°	20							
Max. measurable slope angle	°	87							

ACCURACY

Flatness deviation	2 mm x 2 mm with 10x objective	U = 0.1 µm
Max. deviation of a height step measurement	height step 1000 µm height step 100 µm height step 10 µm height step 1 µm	$E_{Uni: St: ODS, MPE}$ = 1 µm, σ = 0.1 µm $E_{Uni: St: ODS, MPE}$ = 0.4 µm, σ = 0.05 µm $E_{Uni: St: ODS, MPE}$ = 0.3 µm, σ = 0.025 µm $E_{Uni: St: ODS, MPE}$ = 0.15 µm, σ = 0.01 µm
Profile roughness	Ra = 0.5 µm	U = 0.04 µm, σ = 0.002 µm
Area roughness	Sa = 0.5 µm	U = 0.03 µm, σ = 0.002 µm
Distance measurement	XY up to 2 mm	$E_{Bi: Tr: ODS, MPE}$ = 0.8 µm
Wedge angle	β = 70-110 °	U = 0.15 °, σ = 0.02 °
Edge radius	R = 5 µm - 20 µm R > 20 µm	U = 1.5 µm, σ = 0.15 µm U = 2 µm, σ = 0.3 µm

$E_{Uni: St: ODS, MPE}$ & $E_{Bi: Tr: ODS, MPE}$ conform to ISO 10360-8

Initiative Fair Data Sheet
Specifications in blue mark Alicona specific values.

Real3D

How to measure undercuts

In combination with Real3D, users measure surfaces from numerous perspectives. Components are measured in 3D from various perspectives and then automatically merged into a full 3D dataset. High-precision and calibrated rotation and tilt axes ensure automated, repeatable and traceable measurement of form and roughness on the whole measurement object. Users are able to visualize and measure surface features such as diverse flank angles, thread pitch and undercuts.

Alicona offers several options for Real3D measurements. The Advanced Real3D Rotation Unit is equipped with a motorized tilt axis and motorized rotation axes, whereas the Real3D Rotation Unit is based on motorized rotation axes and a manual tilt axis. Both models are used for full form measurement of typically round tools. The fully motorized version can additionally be applied for the automatic measurement of cutting dies, micro hole measurement and Reverse Engineering. Further, users are able to measure trail and main edges of their drill, cutting miller etc. in only one measurement circle.

The compatibility of both units with a number of clamping systems allows for precise and rapid interaction between processing and measurement. In addition, various adapters enable 360° rotation and components without rotational symmetry.

AdvancedReal3D RotationUnit G2

Real3D Rotation Unit G2

AdvancedReal3DRotationUnit

GENERAL SPECIFICATIONS

Rotation axis	360° endless rotation; motorized
Tilt axis	-15° to +90°; motorized
Max torque rotation axis	0.5 Nm
Max. torque tilt axis	2.5 Nm
Clamping repeatability	2 µm (3R and EROWA)
Compatibility	Clamping systems*: three-jaw lever scroll chuck; 3R-SP26771 MacroHP; EROWA ITS Chuck 100P

* Other clamping systems available upon request

MEASUREMENT OBJECT

Max. weight	4kg
Clamping diameter	2 mm - 71 mm (three-jaw chuck); up to 100 mm (3R and EROWA)
Clear aperture	23.5 mm (three-jaw chuck)
Max. length	268 mm (three-jaw chuck), 155 mm (3R), 149 mm (EROWA)

Real3DRotationUnit

GENERAL SPECIFICATIONS

Rotation axis	360° endless rotation; motorized
Tilt axis	- 15° to + 90°, locking every 5°; manual
Max. torque rotation axis	0.1 Nm
Compatibility	Clamping systems: three-jaw lever scroll chuck; ER16 collet chuck

MEASUREMENT OBJECT

Max. weight	0.5 kg
Clamping diameter	0.5 mm - 40 mm (three-jaw chuck); 1 mm - 10 mm (collet chuck)
Clear aperture	12 mm (three-jaw chuck); 12.5 mm (collet chuck)
Max. length	150 mm (three-jaw chuck and collet chuck)

Depending on the geometry of the specimen the indicated parameters may be limited.

InfiniteFocus X-Large

Alicona´s X-Large versions of InfiniteFocus are used for high resolution, optical 3D measurement of large and heavy components. The systems differ in possible XY travel ranges and max. measurable weight of components. The available spectrum of InfiniteFocus X-Large solutions includes travel ranges of (mm) 500 x 500 and 1000 x 1000 with a maximum weight of up to 200kg – more on request. X-Large systems are used for automatic defect analysis of large measurement fields or dimensional measurement of laser structured geometries on printing plates. With an automation interface, InfiniteFocus X-Large systems are also applied for fully automatic measurement in production.

InfiniteFocus X-Large 1000

GENERAL SPECIFICATIONS

Positioning volume (X x Y x Z)	1000 mm x 1000 mm x 100 mm = 100 million mm^3
Coaxial illumination	white LED coaxial illumination, high-power, electronically controllable
Ring light illumination (optional)	white LED high-power ring light, 24 segments, wireless, snap-on system
Dimensions (W x D x H)	measurement instrument: 1680 mm x 785 mm x 1700 mm; ControlServerHP: 200 mm x 485 mm x 440 mm
Mass	measurement instrument: 3080 kg; ControlServerHP: 19 kg
Objectives	2.5x, 5x, 10x, 20x, 50x, 100x

MEASUREMENT OBJECT

Surface texture	surface topography Ra above 0.009 µm with λ_c 2 µm; depending on surface structure
Max. height	100 mm; more on request
Max. size	1000 mm x 1000 mm
Max. weight	200 kg
Preparation	none

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InfiniteFocus X-Large 500

GENERAL SPECIFICATIONS

Positioning volume (X x Y x Z)	500 mm x 500 mm x 100 mm = 25 million mm^3
Coaxial illumination	white LED coaxial illumination, high-power, electronically controllable
Ring light illumination (optional)	white LED high-power ring light, 24 segments, wireless, snap-on system
Dimensions (W x D x H)	measurement instrument: 900 mm x 1100 mm x 800 mm; ControlServerHP: 200 mm x 485 mm x 440 mm
Mass	measurement instrument: 500 kg; ControlServerHP: 19 kg
Objectives	2.5x, 5x, 10x, 20x, 50x, 100x

MEASUREMENT OBJECT

Surface texture	surface topography Ra above 0.009 µm with λ_c 2 µm; depending on surface structure
Max. height	100 mm; more on request
Max. size	500 mm x 500 mm

Initiative **Fair Data Sheet**

Specifications in blue mark Alicona specific values.

IF-SensorR25

Robust 3D measurement in production

IF-SensorR25 is a solid optical 3D measurement instrument for automated form and roughness measurement in production. The sensor is integrated into a production line and delivers high resolution, repeatable and traceable results when measuring surface characteristics in the µm or sub-µm range. Therefore, the IF-SensorR25 is a platform that enables the use of the same measurement process both in-line and in ameasurement laboratory. Standardized interfaces (e.g. QDAS) support an easy and quick integration into production allowing comparable measurements. In combination with a collaborative 6-axis robot, IF-SensorR25 is used as a collaborative system – "Cobot" – for flexible quality assurance and the measurement of microstructures on large components.

GENERAL SPECIFICATIONS

Positioning volume (Z)	25 mm (mot.)

OBJECTIVE SPECIFIC FEATURES

Objective magnification (*)		**10x**	**20x**	**50x**	**2xSX**	**5xAX**	**10xAX**	**20xAX**	**50xSX**
Working distance	mm	17.5	16	10.1	34	34	33.5	20	13
Lateral measurement area (X,Y) **(X x Y)**	mm mm^2	2 4	1 1	0.4 0.16	10 100	3.6 13.03	2 4	1 1	0.4 0.16
Measurement point distance	µm	1	0.5	0.2	5	2	1	0.5	0.2
Finest lateral topographic resolution	µm	2	1	0.64	10	4	2	1	0.64
Measurement noise	nm	40	20	10	1240	165	45	25	15
Vertical resolution	nm	100	50	20	3500	460	130	70	45
Vertical measurement range	mm	16	15	9	25	25	25	19	12
Measurement speed		≤ 1.7 million measurement points/sec.							
Accessibility	°	31	29	19	40	51	51	39	26

(*) Objectives with longer working distance available upon request

RESOLUTION AND APPLICATION SPECIFICATIONS

Objective magnification		**10x**	**20x**	**50x**	**2xSX**	**5xAX**	**10xAX**	**20xAX**	**50xSX**
Min. measurable height	nm	100	50	20	3500	460	130	70	45
Max. measurable height	mm	16	15	9	25	25	25	19	12
Height step accuracy (1 mm)	%	0.1							
Min. measurable roughness (Ra)	µm	0.3	0.15	0.08	n.a.	n.a.	0.45	0.25	0.15
Min. measurable roughness (Sa)	µm	0.15	0.075	0.05	n.a.	n.a.	0.25	0.1	0.08
Min. measurable radius	µm	5	3	2	20	10	5	3	2
Min. measurable wedge angle	°	20							
Max. measurable slope angle	°	87							

ACCURACY

Flatness deviation	2 mm x 2 mm with 10x objective	U = 0.1 µm
Max. deviation of a height step measurement	height step 1000 µm height step 100 µm height step 10 µm height step 1 µm	$E_{Uni: St: ODS, MPE}$ = 1 µm, σ = 0.1 µm $E_{Uni: St: ODS, MPE}$ = 0.4 µm, σ = 0.05 µm $E_{Uni: St: ODS, MPE}$ = 0.3 µm, σ = 0.025 µm $E_{Uni: St: ODS, MPE}$ = 0.15 µm, σ = 0.01 µm
Profile roughness	Ra = 0.5 µm	U = 0.04 µm, σ = 0.002 µm
Area roughness	Sa = 0.5 µm	U = 0.03 µm, σ = 0.002 µm
Distance measurement	XY up to 2 mm	$E_{Bi: Tr: ODS, MPE}$ = 0.8 µm
Wedge angle	β = 70 ° - 110 °	U = 0.15 °, σ = 0.02 °
Edge radius	R = 5 µm - 20 µm R > 20 µm	U = 1.5 µm, σ = 0.15 µm U = 2 µm, σ = 0.3 µm

$E_{Uni: St: ODS, MPE}$ & $E_{Bi: Tr: ODS, MPE}$ conform toISO 10360-8

SOFTWARE

Interface	integrated scripting language; LabVIEW framework; .NET remoting interface; Alicona Inspect Professional (enables GD&T measurement)

Initiative Fair Data Sheet
Specifications in blue mark Alicona specific values.

Alicona´s cobot range

Collaborative systems enable modern production strategies

The Alicona cobot range is based on the combination of a collaborative 6-axis robot and the robust optical 3D measurement sensor IF-SensorR25, delivering high resolution, traceable and repeatable measurements. Collaborative systems are tailored to the individual measurement task and application. Programming and measuring as well as handling of pre-defined measurement programs require no prior knowledge of metrology. Cobots run in both manual and automatic mode and can be optimally integrated into an existing production line. Users verify surface state as well as dimensional accuracy of components by measuring distances, angles, form deviations and position tolerances.
New Cobots that are proven in the field are the DiscCobot to measure turbine discs, and the ToolCobot, which is applied to measure tools also directly in the machine. The CompactCobot is a universal solution applicable in all industries to measure micro structured surfaces of large components.

GENERAL SPECIFICATIONS

Robot type	UR-10
Specimen radius	1300 mm
Safety	collaborative – stops at collision with an object; certified by TÜV Nord and TÜV Süd
Axes	6 rotating joints
Repeatability	+/- 0.1 mm
Sensor	IF-SensorR25 - travel range in Z 26mm motorized - LED ring light with 24 segments - 126 mm x 153 mm x 202 mm (W x D x H)
Mass (incl. sensor)	approx. 30 kg
Operation	coarse positioning of the sensor through handles; fine positioning through precise joystick movement
Display	integrated touchscreen to display the live view and 3D view of the measured dataset
Software compatibility	**AutomationManager:** Easy teach-in of measurement sequences by adding robot positions, SingleField and ImageField measurements. **CADCAM:** Virtual planning of measurement sequence on CAD model incl. simulation of the measurement task.

CompactCobot

Dimensions (H x W x L)	0,95 x 0,79 x 1,35 m
Weight	400 kg
Max. sample weight	ca. 100 kg
Operation	Drawer with integrated 19,5´ touchscreen
Interface	Hole grid plate for mounting different sample holders and samples
Additional Features	Integrated status lights 4 emergency stops on each corner

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DiscCobot

Dimensions	control console: 1 x 1 x 0.9 m; system: 1.0 x 1.45 x 0.95 m (excl. cobot)
Mass	approx. 1.5 t
Additional axes	rotation axis
Max. specimen weight	approx. 150 kg
Interface	flexible perforated plate for mounting of grips
Safety	laser scanner for additional monitoring of the operating range

ToolCobot

Dimensions	1.5 x 0.95 x 2.15 m
Mass	approx. 900 kg
Additional axes	rotation table lifting axis with 400 mm travel range
Max. specimen weight	approx. 50 kg
Operation	sliding drawer with integrated touchscreen
Interface	Taper50 interface (other options possible) incl. perforated plate for mounting of grips
Mobility	height-adjustable casters for flexible use

IF-PortableRL

Mobile, high resolution measurement

IF-PortableRL is an optical 3D measurement system for quality assurance of micro structured surfaces. Users verify measurement fields of up to (mm) 50x50x26. The system is applied for both curved and flat components. A battery pack allows a flexible use and mobile positioning, enabling the use of the system wherever needed. A large vertical scanning range allows the measurement of various geometry types and forms. Amongst others, fields of use are platen inspection, asphalt measurement, quality assurance of turbine or rotor blades, 3D measurement of steel and body parts.

Mesurement on a Racetrack

MobilityCase

Battery pack

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GENERAL SPECIFICATIONS

Positioning volume (X x Y x Z)	50 mm x 50 mm x 25 mm = 62500mm³

OBJECTIVE SPECIFIC FEATURES

Objective magnification (*)		**10x**	**20x**	**50x**	**2xSX**	**5xAX**	**10xAX**	**20xAX**	**50xSX**
Numerical aperture		0.3	0.4	0.6	0.055	0.14	0.28	0.42	0.55
Working distance	mm	17.5	16	10.1	34	34	33.5	20	13
Lateral measurement area (X,Y) **(X x Y)**	mm mm²	2 4	1 1	0.4 0.16	10 100	3.61 13.03	2 4	1 1	0.4 0.16
Measurement point distance	µm	1	0.5	0.2	5	2	1	0.5	0.2
Calculated lateral optical limiting resolution	µm	1.09	0.82	0.54	5.93	2.33	1.17	0.78	0.59
Finest lateral topographic resolution	µm	2	1	0.64	10	4	2	1	0.64
Measurement noise	nm	60	30	20	1240	165	60	30	25
Vertical resolution	nm	150	75	50	3500	460	170	90	70
Vertical measurement range	mm	16	15	9	25	25	25	19	12
Measurement speed	≤ 1.7 million measurement points/sec.								
Accessibility	°	31	29	19	40	51	51	39	26

(*) Objectives with longer working distance available upon request

RESOLUTION AND APPLICATION SPECIFICATIONS

Objective magnification		**10x**	**20x**	**50x**	**2xSX**	**5xAX**	**10xAX**	**20xAX**	**50SX**
Height step accuracy (1 mm)	%	0.1							
Min. measurable roughness (Ra)	µm	0.55	0.25	0.2	n.a.	n.a.	0.65	0.3	0.25
Min. measurable roughness (Sa)	µm	0.30	0.15	0.1	n.a.	n.a	0.35	0.15	0.13
Min. measurable radius	µm	5	3	2	20	10	5	3	2
Min. measurable wedge angle	°	20							
Max. measurable slope angle	°	87							

ACCURACY

Flatness deviation	2 mm x 2 mm with 10x objective	U = 0.1 µm
Max. deviation of a height step measurement	height step 1000 µm height step 100 µm height step 10 µm height step 1 µm	$E_{Uni: St: ODS, MPE}$ = 1 µm, σ = 0.1 µm $E_{Uni: St: ODS, MPE}$ = 0.4 µm, σ = 0.05 µm $E_{Uni: St: ODS, MPE}$ = 0.3 µm, σ = 0.025 µm $E_{Uni: St: ODS, MPE}$ = 0.15 µm, σ = 0.01 µm
Profile roughness	Ra = 0.5 µm	U = 0.04 µm, σ = 0.002 µm
Area roughness	Sa = 0.5 µm	U = 0.03 µm, σ = 0.002 µm
Distance measurement	XY up to 2 mm	$E_{Bi: Tr: ODS, MPE}$ = 0.8 µm
Wedge angle	β = 70-110 °	U = 0.15 °, σ = 0.02 °
Edge radius	R = 5 µm - 20 µm R > 20 µm	U = 1.5 µm, σ = 0.15 µm U = 2 µm, σ = 0.3 µm

$E_{Uni: St: ODS, MPE}$ & $E_{Bi: Tr: ODS, MPE}$ conform to ISO 10360-8

Initiative **Fair Data Sheet**
Specifications in blue mark Alicona specific values.

IF-Profiler

3D profiler to measure roughness and surface finish

IIF-Profiler is a handheld 3D roughness measurement system for high resolution measurement of surface finish. Users measure roughness of flat and curved components with only one system. Measurements are performed both profile based (ISO 4287) and areal based (ISO 25178). The lightweight IF-Profiler consists of a 3D measurement sensor and a robust, at the same time handy framework. The ergonomic design combines ease of use and required mechanical rigidity. Traceable and repeatable measurements are achieved in a min. measurement time of three seconds.

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GENERAL SPECIFICATIONS

Positioning volume (Z)	25 mm (mot.)
Specimen radius	100 mm - ∞

OBJECTIVE SPECIFIC FEATURES

Objective magnification (*)		**10x**	**20x**	**50x**
Numerical aperture		0.3	0.4	0.6
Working distance	mm	17.5	16	10.1
Lateral measurement area (X,Y) **(X x Y)**	mm mm^2	2 4	1 1	0.4 0.16
Measurement point distance	µm	1	0.5	0.2
Calculated lateral optical limiting resolution	µm	1.09	0.82	0.54
Finest lateral topographic resolution	µm	2	1	0.64
Measurement noise	nm	40	20	10
Vertical resolution	nm	100	50	20
Vertical measurement area	mm	16	15	9
Accessibility	°	31	29	19

(*) Objectives with longer working distance available upon request

RESOLUTION AND APPLICATION SPECIFICATIONS

Objective magnification (*)		**10x**	**20x**	**50x**
Min. measurable roughness (Ra)	µm	0.3	0.24	0.18
Min. measurable roughness (Sa)	µm	0.15	0.12	0.09
Max. measurable slope angle	°	87		

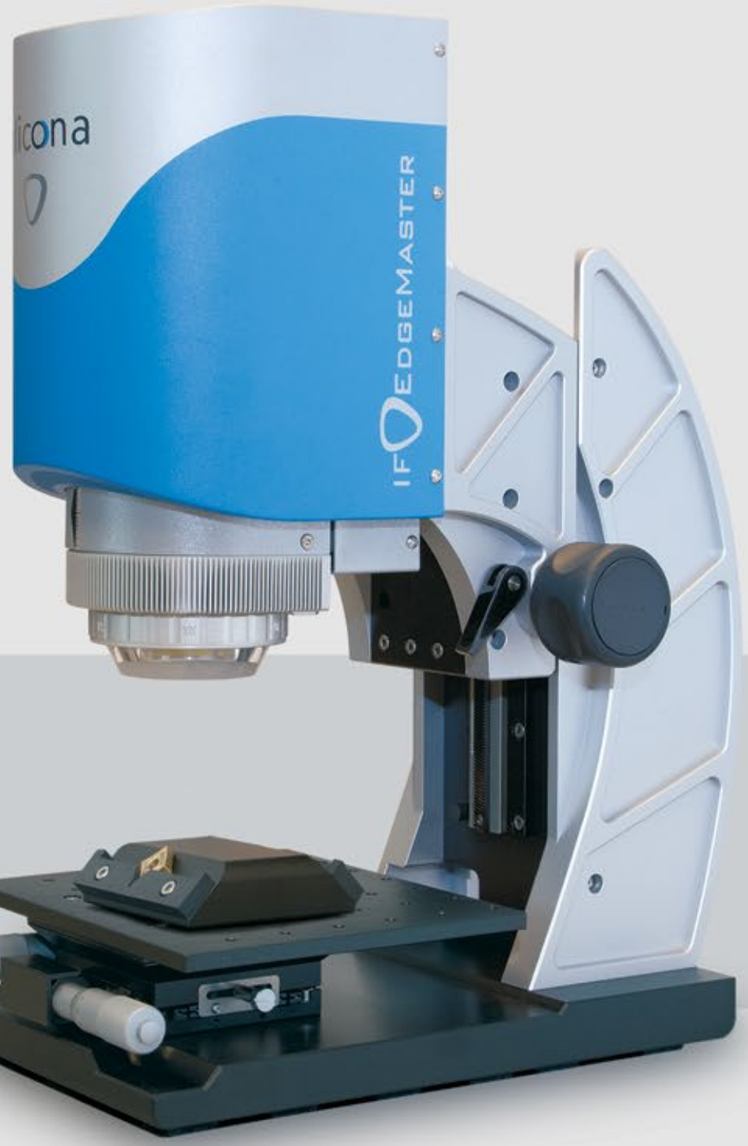
Initiative **Fair Data Sheet**

Specifications in blue mark Alicona specific values.

EdgeMaster

Automatic cutting edge measurement in production

The EdgeMaster is an optical 3D measurement device for automatic cutting edge measurement. Edges of inserts, drills, millers and other round tools are measured regardless of type, size, material, or surface finish. Users measure radii >2µm as well as rake, wedge and clearance angle of tools. Different types, including both waterfall and trumpet, are precisely measured. Traceable and repeatable results are delivered in high vertical resolution even at vibrations, variations in temperature and ambient light. In addition to chipping measurement, the high vertical resolution also enables traceable roughness measurement on the rake face.



RotationGrip

AdvancedInsertGrip

InsertGrip G2

ToolGrip

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GENERAL SPECIFICATIONS

Positioning volume (X x Y x Z)	RL objectives: man.: 25 mm x 25 mm x 155 mm (Z: 25 mm mot., 130 mm man.) = 96875 mm³ SXRL/AXRL objectives: man.: 25 mm x 25 mm x 120 mm (Z: 25 mm mot., 95 mm man.) = 75000mm³
Max. specimen weight	4 kg; more on request

OBJECTIVE SPECIFIC FEATURES

Objective magnification (*)		**10x**	**20x**	**50x**	**2xSX**	**5xAX**	**10xAX**	**20xAX**	**50xSX**
Working distance	mm	17.5	16	10.1	34	34	33.5	20	13
Lateral measurement area (X,Y) **(X x Y)**	mm mm²	2 4	1 1	0.4 0.16	10 100	3.61 13.03	2 4	1 1	0.4 0.16
Measurement point distance	µm	1	0.5	0.2	5	2	1	0.5	0.2
Measurement noise	nm	40	20	10	1240	165	45	25	15
Vertical resolution	nm	100	50	20	3500	460	130	70	45
Vertical measurement range	mm	16	15	9	25	25	25	19	12
Accessibility	°	31	29	19	40	51	51	39	26

(*) Objectives with longer working distance available upon request

RESOLUTION AND APPLICATION SPECIFICATIONS

Objective magnification		**10x**	**20x**	**50x**	**2xSX**	**5xAX**	**10xAX**	**20xAX**	**50SX**
Min. measurable radius	µm	5	3	2	20	10	5	3	2
Min. measurable wedge angle	°	20							
Min. measurable roughness (Ra)	µm	0.3	0.15	0.08	n.a.	n.a.	0.45	0.25	0.15
Min. measurable roughness (Sa)	µm	0.15	0.075	0.05	n.a.	n.a	0.25	0.1	0.08
Max. bevel length	µm	800	400	160	4000	2000	800	400	160
Max. measurable slope angle	°	87							

ACCURACY

Profile roughness	Ra = 0.5 µm	U = 0.04 µm, σ = 0.002 µm
Area roughness	Sa = 0.5 µm	U = 0.03 µm, σ = 0.002 µm
Wedge angle	β = 70 ° - 110 °	U = 0.15 ° , σ = 0.02 °
Edge radius	R = 5 µm - 20 µm R > 20 µm	U = 1.5 µm, σ = 0.15 µm U = 2 µm, σ = 0.3 µm

Initiative **Fair Data Sheet**

Specifications in blue mark Alicona specific values.

EdgeMasterX

Multiple edges in only one measurement run

The EdgeMasterX originates from the Alicona product line for optical, automatic tool measurement in high resolution. It is a fully automated cutting edge measurement system for quality assurance of drills, millers and other round tools to be applied in production. Specifically, the EdgeMasterX enables automated multi-edge measurement. When utilized in combination with a motorized rotation unit, users benefit from the measurement of multiple tool edges, even chamfered edges, in one single measurement run. Deviations from a CAD file or reference geometry are indicated through a traffic light system. Measurements are initiated by a single button solution allowing for measurements to be performed without any further user interaction.

Real3D Rotation Unit G2

RotationGrip

AdvancedInsertGrip

InsertGrip G2

ToolGrip

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GENERAL SPECIFICATIONS

Positioning volume (X x Y x Z)	RL objectives: mot.: 50 mm x 50 mm x 155 mm (Z: 25 mm mot., 130 mm man.) = 387500 mm³ SXRL/AXRL-objectives: mot.: 50 mm x 50 mm x 120 mm (Z: 25 mm mot., 95 mm man.) = 300000 mm³
Max. specimen weight	4 kg; more on request

OBJECTIVE SPECIFIC FEATURES

Objective magnification (*)		**10x**	**20x**	**50x**	**2xSX**	**5xAX**	**10xAX**	**20xAX**	**50xSX**
Working distance	mm	17.5	16	10.1	34	34	33.5	20	13
Lateral measurement area (X,Y) **(X x Y)**	mm mm^2	2 4	1 1	0.4 0.16	10 100	3.61 13.03	2 4	1 1	0.4 0.16
Measurement point distance	µm	1	0.5	0.2	5	2	1	0.5	0.2
Measurement noise	nm	40	20	10	1240	165	45	25	15
Vertical resolution	nm	100	50	20	3500	460	130	70	45
Vertical measurement range	mm	16	15	9	25	25	25	19	12
Accessibility	°	31	29	19	40	51	51	39	26

(*) Objectives with longer working distance available upon request

RESOLUTION AND APPLICATION SPECIFICATIONS

Objective magnification		**10x**	**20x**	**50x**	**2xSX**	**5xAX**	**10xAX**	**20xAX**	**50SX**
Min. measurable radius	µm	5	3	2	20	10	5	3	2
Min. measurable roughness (Ra)	µm	0.3	0.15	0.08	n.a.	n.a.	0.45	0.25	0.15
Min. measurable roughness (Sa)	µm	0.15	0.075	0.05	n.a.	n.a.	0.25	0.1	0.08
Max. bevel length	µm	800	400	160	4000	2000	800	400	160
Min. measurable wedge angle	°	20							
Max. measurable slope angle	°	87							

ACCURACY

Profile roughness	Ra = 0.5 µm	U = 0.04 µm, σ = 0.002 µm
Area roughness	Sa = 0.5 µm	U = 0.03 µm, σ = 0.002 µm
Wedge angle	β = 70 ° - 110 °	U = 0.15 ° , σ = 0.02 °
Edge radius	R = 5 µm - 20 µm R > 20 µm	U = 1.5 µm, σ = 0.15 µm U = 2 µm, σ = 0.3 µm

Initiative Fair Data Sheet

Specifications in blue mark Alicona specific values.

EdgeMasterHOB

Optical cutting edge measurement of hob cutters

The EdgeMasterHOB is one of Alicona´s optical tool measurement systems and a market-specific adaption of the optical cutting edge measurement system EdgeMaster. Like all Alicona tool measurement systems, the EdgeMasterHOB is used for automated quality assurance. The hob measuring device is particularly applied in e.g. regrinding centers. A working distance of 33mm allows effortless measurement of cutting edges even in areas that are hard to access. Users measure, amongst other features, chipping and edge defects, chamfer as well as edge roundness at the tooth flank, tooth root and tooth tip.

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GENERAL SPECIFICATIONS

Positioning volume	Z: 25 mm (mot.), 92 mm (man.) Lifting table: 120 mm (man.) Rotation table: +/- 30° (man.)
Max. specimen weight	30 kg; more on request

OBJECTIVE SPECIFIC FEATURES

Objective magnification (*)		**5xAX**	**10xAX**	**20xAX**
Numerical aperture		0.14	0.28	0.42
Working distance	mm	34	33.5	20
Lateral measurement area (X,Y) **(X x Y)**	mm mm^2	3.61 13.03	2 4	1 1
Measurement point distance	µm	2	1	0.5
Calculated lateral optical limiting resolution	µm	2.33	1.17	0.78
Finest lateral topographic resolution	µm	4	2	1
Measurement noise	nm	165	45	25
Vertical resolution	nm	460	130	70
Vertical measurement area	mm	25	25	19
Accessibility	°	51	51	39

(*) Objectives with longer working distance available upon request

RESOLUTION AND APPLICATION SPECIFICATIONS

Objective magnification		**5xAX**	**10xAX**	**20xAX**
Min. measurable radius	µm	10	5	3
Min. measurable wedge angle	°	20		
Max. measurable slope angle	°	87		
Max. bevel length	µm	2000	800	400

ACCURACY

Wedge angle	β = 70 ° - 110 °	U = 0.15 ° , σ = 0.02 °
Edge radius	R = 5 µm - 20 µm R > 20 µm	U = 1.5 µm, σ = 0.15 µm U = 2 µm, σ = 0.3 µm

Initiative **Fair Data Sheet**

Specifications in blue mark Alicona specific values.

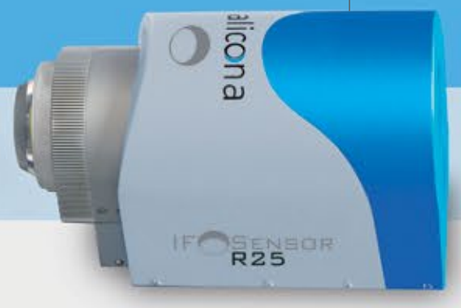
InfiniteFocusSL

IF-Profiler

InfiniteFocus X-Large

EdgeMaster

IF-SensorR25



IF-PortableRL

EdgeMasterX

EdgeMasterHob

InfiniteFocus

Form and roughness. In one system.

By Alicona. That´s metrology!

Optical 3D surface measurement

InfiniteFocus is based on the technology of Focus-Variation. Users measure form and roughness in the µm and sub- µm area. With the new generation of InfiniteFocus, Alicona supplies the fastest optical sensor in its class.

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