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InFocus

Polytec

Optical measurement solutions

The smoking gun

How surface metrology reveals the finest forensic details

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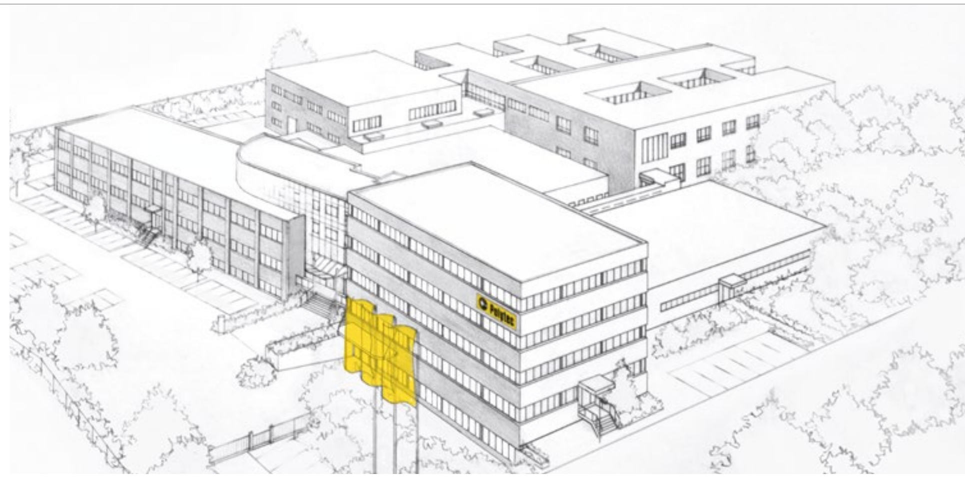

Dear readers,

Almost all aspects of our daily, modern lives are affected by technology and technical products that depend on high-quality measurement data for their development, design, manufacture, and implementation. Our transportation, communication, healthcare, and agricultural systems must be reliable, economical, safe, environmentally sound (i.e., quiet), and effective. For more than 50 years, Polytec has provided innovative, non-contact sensor and measurement solutions that engineers use to push technology in all of these fields. In particular, Polytec is continuously innovating non-contact laser vibrometry, helping to advance all of its many applications from the smallest MEMS devices to automotive and aerospace designs, and the largest bridges and buildings.

In this exciting issue of InFocus, we present inspiring contributions that describe the impact of optical measurement data on the efficiency and safety of ground and air travel, on the thoughtful resolution of environmental issues in agriculture, on the improvement of high-tech tools for healthcare, and on the delivery of better forensic evidence in criminal investigations.

Finally, we showcase new solutions for your measurement tasks, ranging from the portable and battery-powered VibroGo for research and field studies using vibrometry to the MSA-600 X/U Micro System Analyzer for characterizing ultra-high frequency MEMS and micro-acoustic devices.

We are pushing the limits of our technology to inspire you and help find innovative solutions to your measurement applications. Contact us with all your questions. We look forward to providing the answers.

Eric Winkler
Vice President
Business Unit Optical Measurement Systems

Content

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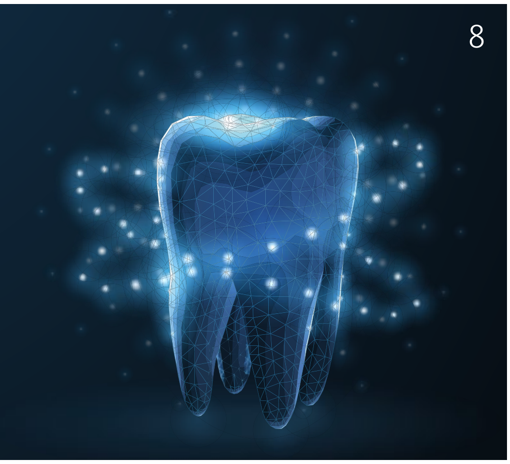

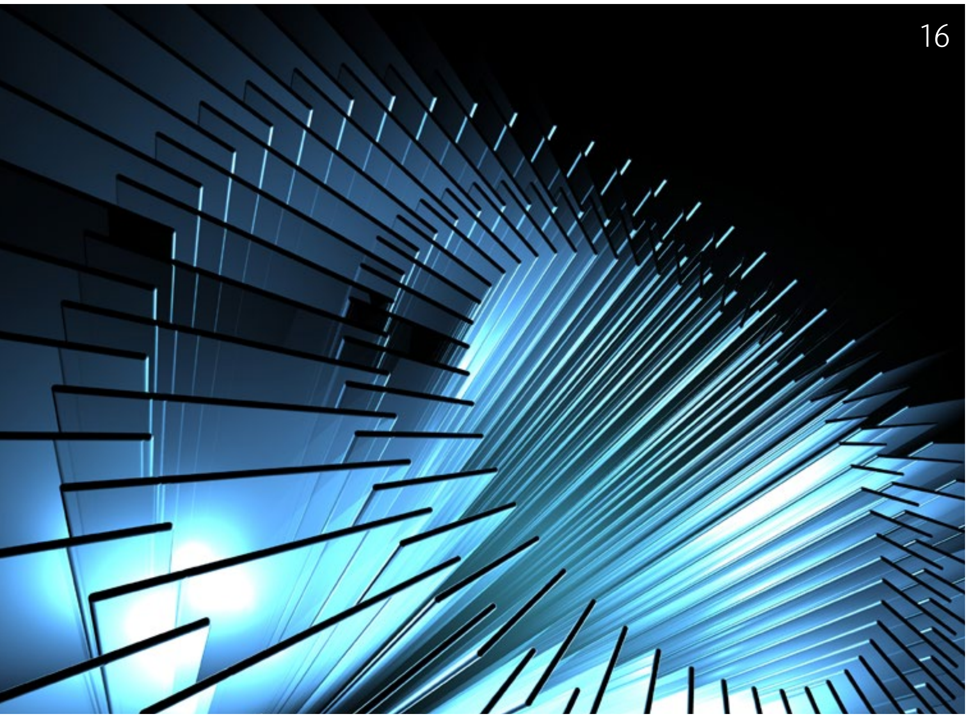

The smoking gun

How surface metrology reveals the finest forensic details

Polytec

Forensic science plays a vital role in the criminal justice system by providing scientifically based information through the analysis of physical evidence. During an investigation, evidence is collected at a crime scene or from a person, analyzed in a crime laboratory and then the results are presented in court. Surface metrology (the science of measurement) can be used to study surfaces for the finest of physical details. This finest of information can be used to show how a surface was generated. ▶

MACRO SCALE BALLISTIC TOOL MARK IDENTIFICATION

When a cartridge is fired from a gun, tell-tale markings are transferred from the inner surface of the firearm resulting in plastic deformation of the cartridge. The firing pin hits the primer cap of the cartridge, igniting the primer which in turn causes deflagration of the main propellant. This main propellant forces the slightly oversized bullet through the barrel of the gun, in which it is shaped by the rifling marks of the inner surface. Simultaneously, the cartridge case will be forced into the breech face of the barrel, thus imparting machining marks onto the cartridge base. Finally, the cartridge case is extracted from the breech of the firearm, leaving another impression on the cartridge.

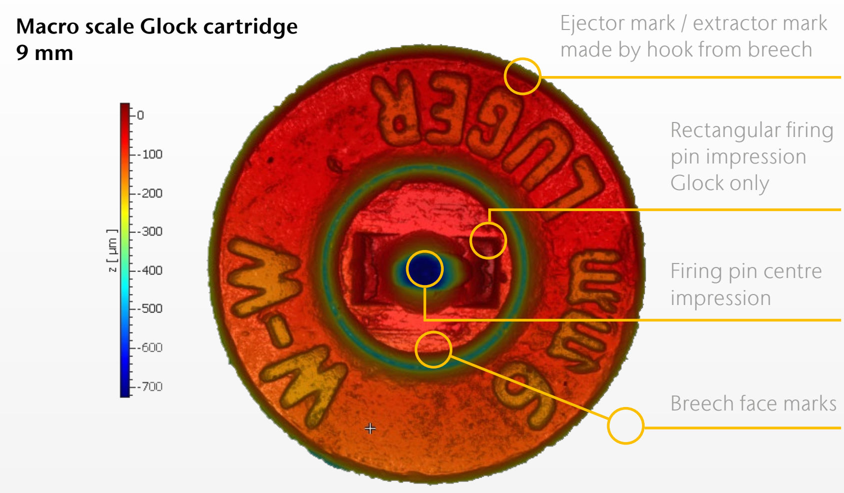

Figure 1: The various spatial scales of information contained within each impression relate to groups of information regarding the firearm it was fired from. Larger scale information relates to the machining processes used on the firearm, and can therefore be used to determine the manufacturer of the firearm. Smaller-scale spatial information may be individual to the one particular firearm, and originate from handling/storage.

Current ballistic tool mark identification techniques rely on the imaging of these tool marks using greyscale microscopy, which is arguably a subjective and unrepeatable methodology. Using areal acquisition, height information of the tool mark can be accurately and objectively gained. Therefore, a shift to the areal acquisition would be a benefit in criminal proceedings, where the accuracy of the information could not be cast into doubt.

Here the surface topography information was captured using the TopMap Pro.Surf from Polytec. The TopMap Pro.Surf is a macro lens coherent scanning interferometer. This instrument offers a large field of view allowing the whole object to be measured within a single data collection routine, which greatly speeds the measurement process when you need non-contact 3D areal base surface topography. The Z-resolution is to the nanometer level providing high resolution to the finest of detail. The technology of data collection can cope with polished, rough, dark and light surface types. All these surface effects are present on the end of the cartridge. Through the lifetime of the cartdridge its end surface undergoes many changes and a final physical transformation at the point of firing. It gets polished, pushed, pulled, coated in carbon and ends up becoming a multi-faceted surface with different reflectivities and surface texture types.

Macro scale forensics
7.5 mm

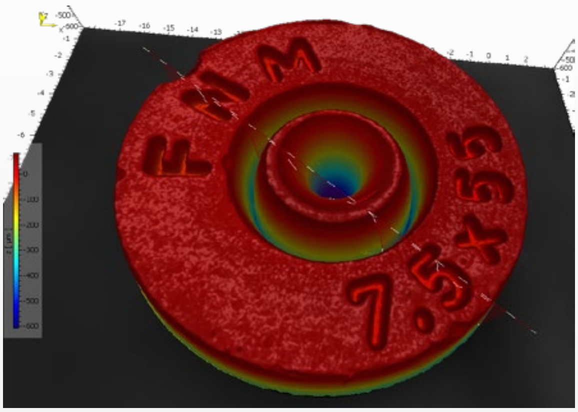

Figure 2: Firearm examination is a forensic tool used to help the court determine whether two bullets were fired from the same gun barrel. During the firing process, rifling, manufacturing defects, and impurities in the barrel create striation marks on the bullet.

Identifying these striation markings in an attempt to match two bullets is one of the primary goals of firearm examination.

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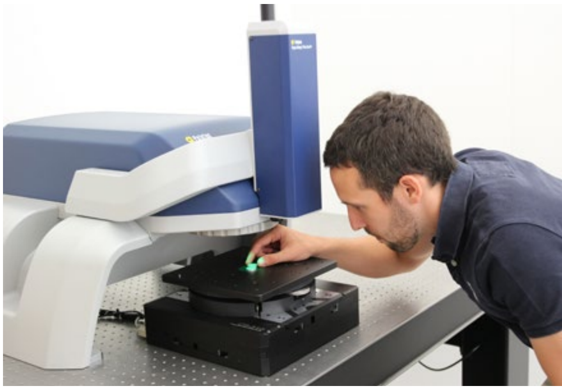
CONCLUSION

Appropriate, high accuracy surface metrology practices and equipment are critical for the advancement of forensic science. Evidence that can be proved to be quantifiable could not be cast into doubt and could prove critical for any legal court proceedings.

Non-contact 3D areal surface topography from Polytec has been proven to be fast, stable and repeatable. The TopMap Pro.Surf although traditionally designed for the industrial manufacturing market, with it's innovative optical measurement technology has shown itself to be suitable for challenging forensic measurements. ■



Improving dental healthcare

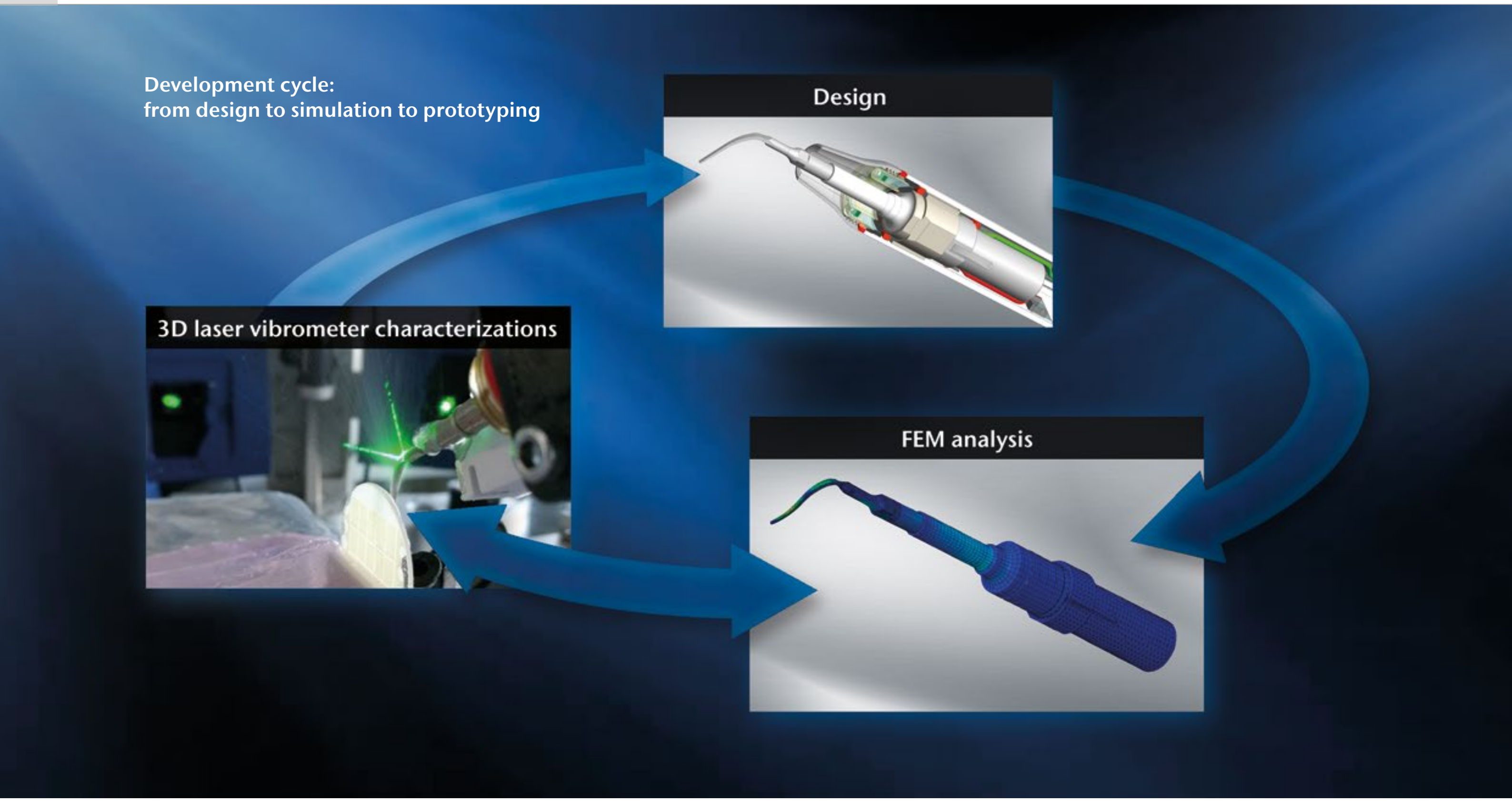
Keep healthy teeth with ultrasonic scaler using EMS Piezon NO-PAIN® technology

Figure 1: Airflow prophylaxis master unit, supporting the concept of the Guided Biofilm Therapy (GBT®). The Piezon® technology is integrated on the left side of the device.

In order to keep your natural teeth as long as possible and to prevent caries and periodontal infections, home-care methods like brushing your teeth and flossing are essential. Unfortunately, these alone are not sufficient. Biofilm arises even if these home care treatments are performed correctly and can lead to calculus formation and to serious diseases. Regular visits to a dentist are necessary for diagnosing the formation of biofilm or calculus and applying preventive techniques to neutralize their growth. A specific protocol developed by E.M.S. Electro Medical Systems S.A. from Switzerland, called Guided Biofilm Therapy (GBT®), ensures the most minimal invasive and comfortable treatment. This protocol includes disclosing and preventive steps, biofilm removal with Airflow® technology (air polishing technology), calculus removal with Piezon® PS (ultrasonic scaler) and at the end controls and recall steps. In order to reach the most efficient treatment with a noninvasive and comfortable approach, we need to master the PS instrument motion. Laser Doppler vibrometry plays an important role and be used in the design and manufacturing of this high-end dental instrument.

In this Guided Biofilm Therapy (GBT®) protocol, Piezon® technology with PS instrument is used due to the linearity of its motion, its efficiency, and its minimal invasiveness on teeth and soft tissue compared to other technologies like manual, air scaling or magnetostricitve devices. The Piezon® system removes calculus through the controlled vibration of the instrument excited by a piezo transducer inside the handpiece. This piezo transducer is driven by the electronic module, included in the unit, which ensures a constant vibration of the instrument. The E.M.S. PS instrument maintains gentle and efficient motion from supragingival to subgingival treatments, thanks to its geometry and the shape of its thin end. The linearity of the motion is ensured only when the entire system is perfectly balanced between the instrument shape, the ultrasonic transducer design and the electronic driving module. It's not the case for some competitors which supply only tips without control on the entire system. In fact, small deviations in geometry, materials, and treatments can degrade performance. In such cases, proper vibrational behavior of the tip may not be ensured, possibly resulting in dangerous motions and patient discomfort. ▶

Figure 2: Piezon® PS, the universal instrument, from supragingival to subgingival treatment.



To ensure proper vibrational motion of its instruments, E.M.S. uses the most advanced technology throughout the whole development and characterization process. Indeed, in the development phase, scanning laser Doppler vibrometers are used to calibrate and validate Finite Elements Models (FEM). During final validation, they are used to control the small acceptable deviations on the transducers and in the instrument fabrication process. With that, the acceptable wear for each instrument is also determined using this advanced measurement technology.

The characterization of the ultrasonic instrument requires contactless analysis methods able to accurately measure small displacements (less than 200 µm peak-to-peak) at a high frequency and in real time, to link the electrical signal sent by the electronic module to the mechanical motion of the instrument. The PSV-500-3D Xtra system offers the ultimate characterization technique in this field, as it is able to measure the complete 3D motion of the tip by scanning its surface and taking the electronic signal sent to the piezo transducer as its phase reference. The scanning vibrometer makes it possible to confirm the linearity of the instrument's motion under real conditions, with contacts on a teeth surface and water spray. In addition, the Polytec's Xtra vibrometer technology broadens the speed range up to 30 m/s, which corresponds, at a scaler working frequency (29 KHz), to displacements of 275 µm peak-to-peak.

RESULTS

The measurement of PS instrument was performed in air, with no mechanical load. The end part of the instrument is mapped with approximately 135 points to precisely define the X; Y; Z motion of the instrument. The result is shown Figure 4.

With these results, we are able to verify our FE model (mode of deformation, frequency, linearity of the ultrasonic motion) and calibrate it (losses) to match with the real amplitude of the ultrasonic motion, see Figure 5.

We can also compare the mechanical measurements with the electrical signal sent by our electronic driver to verify the performance of our control on the output vibration regulation. Furthermore, the laser vibrometer is used to measure the instrument motion under real conditions (with load induce by and contact on teeth and calculus) which are difficult to model in simulation. Even under challenging operating conditions we were able to accurately capture the amplitude in-situ and verify the linearity of the motion.

CONCLUSION

The Polytec PSV-3D Xtra Scanning Vibrometer is able to capture, with an incomparable level of accuracy, the high-speed motion of the ultrasonic PS instrument. Thanks to this measurement technology, we have validated and calibrated our theoretical models, controlled the performances of PS instrument and we characterized how the system reacts during operation. Thanks to the synergy design-simulation-prototyping, laser vibrometer helps us to develop new concepts, to continuously improve our products, and to optimize all key factors in order to ensuring the efficient and non-invasiveness of a prophylaxis treatment: The best technology supporting the best treatment. ■

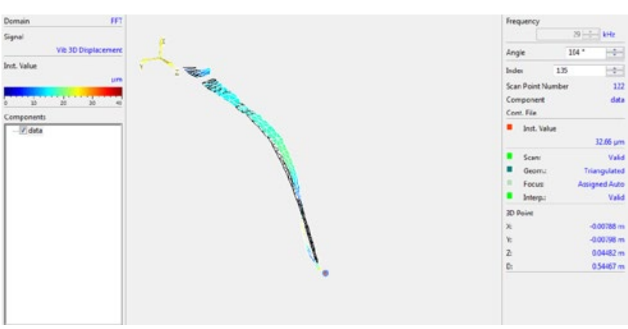


Figure 4: Deflection shape of the PS instrument during ultrasonic activation.

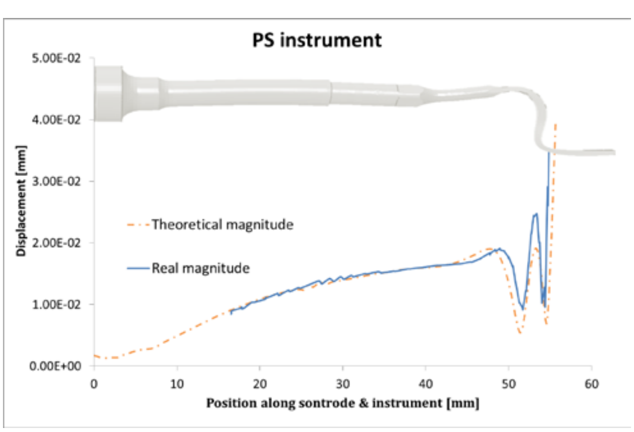


Figure 5: Comparison between real and theoretical amplitude of vibration along a path defined on the sonotrode and the instrument.

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You can find more details about this in the full-length version of this application note at:
www.polytec.com/eu/vibrometry/areas-of-application/biology-and-medicine/

Experimental modal analysis of gear wheels

Measurements using broadband piezoelectric excitation

The following article compares various forms of force excitation in order to determine the transfer admittances of mechanical systems using a gear wheel as an example. The objective is to analyze and assess the acoustic properties of technical structures, e.g. the drive train of an electric vehicle, in the higher frequency range. The experiments demonstrated that with a broadband piezoelectric force excitation the gathered measurement results become far more consistent, especially at high frequencies.

STATE OF THE ART

As the use of electric drives in vehicles increases, new requirements for the acoustic properties of the overall drive train are arising. The conventional internal combustion engine generates a relatively high noise level, which covers certain disturbing noises, e.g. the “gearbox whine”. This “auditory masking” of the internal combustion engine does not apply to electric drives, whereby fractions in the higher frequency range come to the fore. Current research and development activities therefore focus on reducing these acoustic properties.

The transfer response of the components of the drive train is described by “network models” [1] at Fraunhofer IWU. One basis for this approach is the description of the individual components, e.g. a gear wheel, by way of frequency-dependent transfer functions. This is provided by means of harmonic force excitation of the components and measurement of the structural response using 3D laser scanning vibrometry.

Force excitation in the interesting frequency range (up to 20 kHz) represents a challenge to the existing excitation technology, especially in the case of large structures. Electrodynamic shakers or pulse hammers are the state of the art. Often, the applied forces are not high enough to obtain consistent measurement results (absolute value and phase), particularly at higher frequencies (> 5 kHz). A procedure for broadband force excitation using a piezoelectric modal exciter (dm 2) and a comparison with a conventional exciter (Brüel&Kjær 4810) is described in this article. ▶

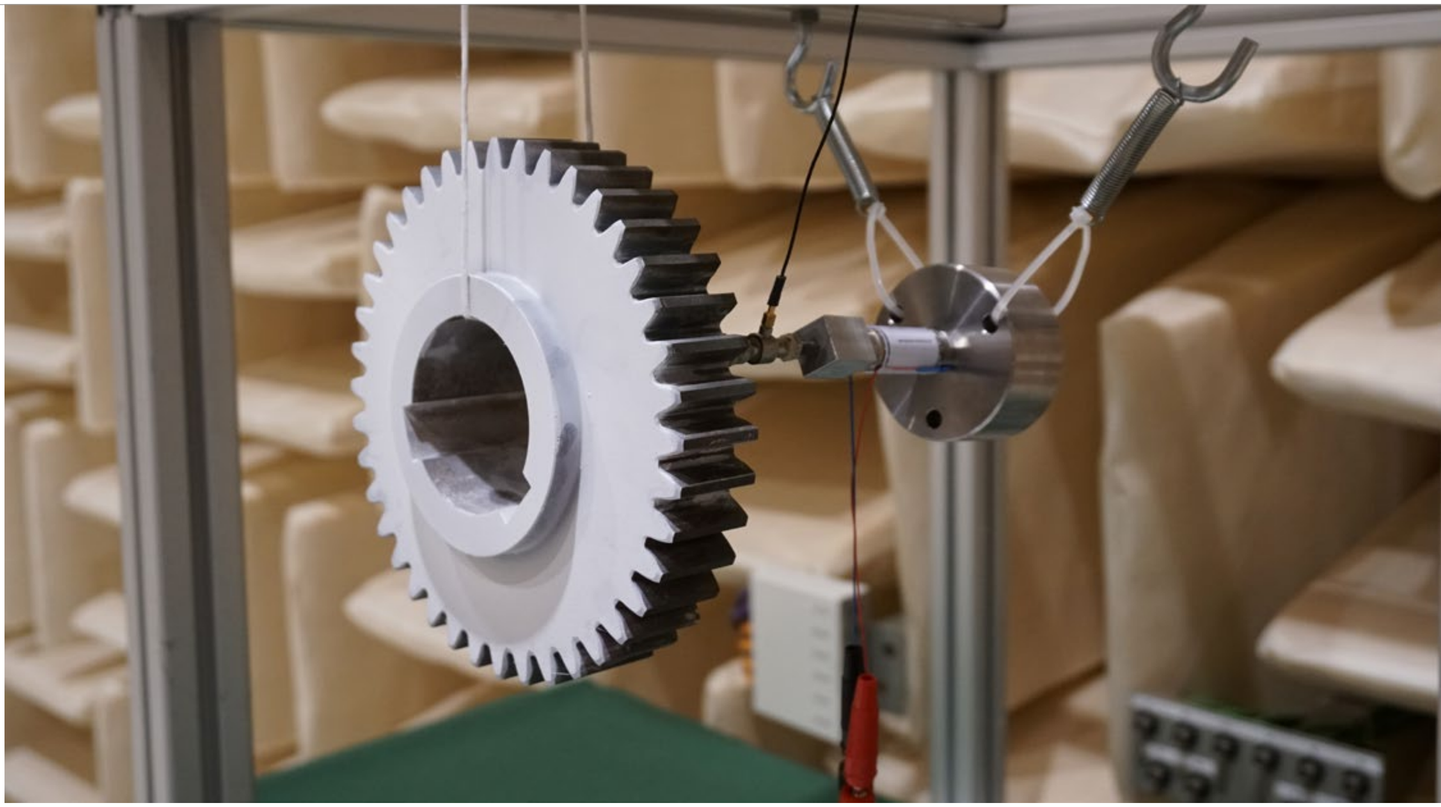

Figure 1: Measurement setup

MEASUREMENT SETUP

The two shakers were compared under free-free boundary conditions, whereby the respective exciter and the test object were suspended in a rack by means of springs and elastic decoupling elements. The rigid coupling between shaker and test object was realized via a load cell (Brüel&Kjær, type 8203). Figure 1 shows the described test setup with the piezoshaker dm 2.

The system response was acquired by means of a Polytec PSV-3D Scanning Vibrometer. A periodic chirp was used as an excitation signal, whereby the specified excitation and evaluation frequency range was 3.5 to 16 kHz (bandwidth 20 kHz, 12800 FFT lines).

RESULTS

Figure 2 shows the comparison of the transfer admittances of the individual measurement points diametrically opposite the point of force application (cf. figure 1). The natural frequencies (marked in red) were determined in a preceding experimental modal analysis using an automated pulse hammer. In addition, the associated coherence profiles are shown in the bottom diagram in figure 2.
It is apparent that the amount of energy that can be applied to the system with the shaker B&K 4810 above approx. 7 kHz is not high enough to obtain a satisfactory signal-to-noise ratio, as illustrated by the respective coherence and the clearly identifiable noise levels in the course of the transfer admittance from 7 kHz. When using the dm 2, it is apparent that this is suitable for acquisition of the system responses in the higher frequency range. Clean acquisition of the transmission functions is possible due to the significantly higher energy input, which is also illustrated by the comparison of the phase frequency responses shown in figure 3.

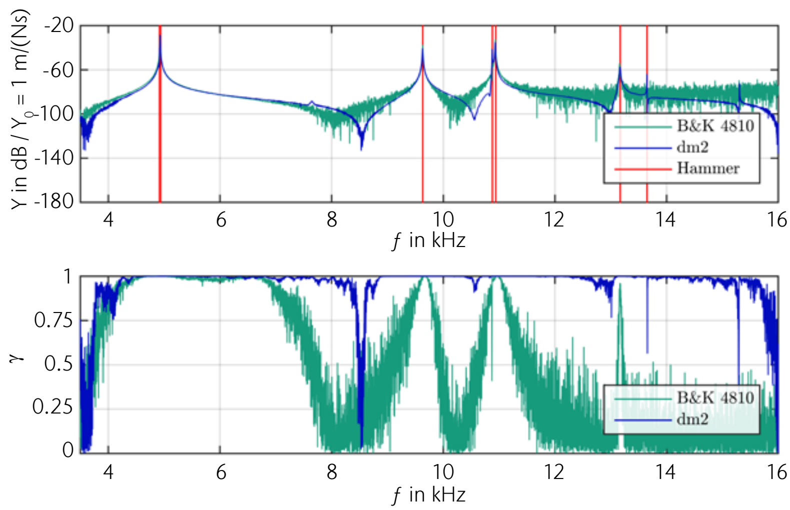

Figure 2: Comparison of the results of a selected scan point
Top: Transfer admittance; Bottom: Associated coherence profile

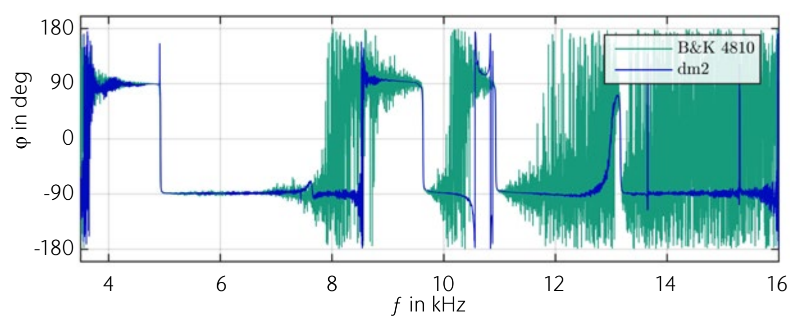

Figure 3: Comparison of the phase frequency responses of the considered scan points

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[1] Bräunig, J. et al.: Options for the vibro-acoustic structure investigation of a wheel body of a tooth system.

In: ant journal, Antriebstechnik 53 (2 2014), p. 3-9.

SUMMARY

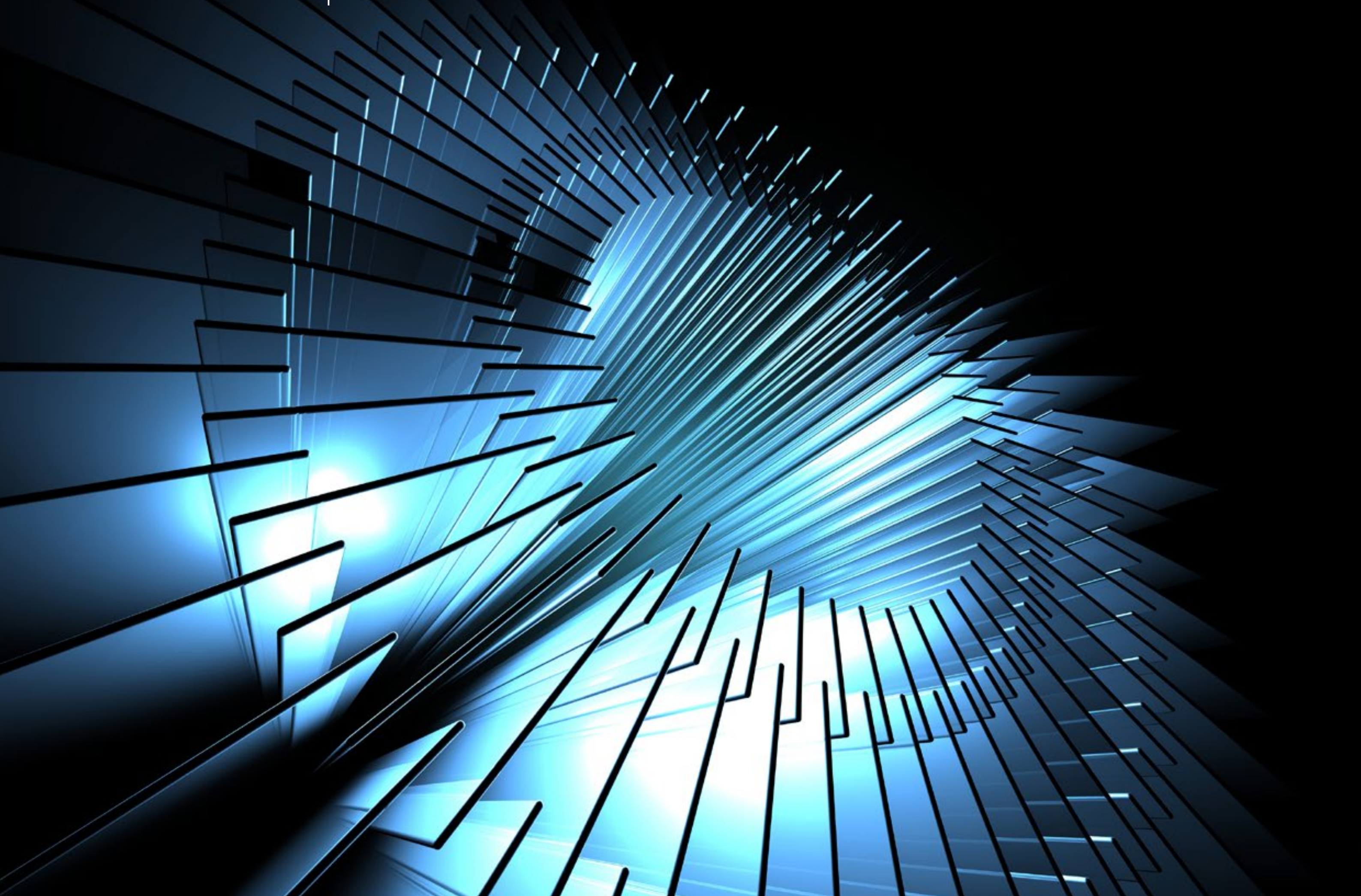
Various force exciters were compared in this article, in order to measure the transfer admittances of gear wheels. The objective was to find a suitable excitation method in the higher frequency range, in order to enable e.g. the description of the acoustic properties of technical structures on the basis of metrologically acquired transmission functions. It was demonstrated that significantly more consistent measurement results can be obtained with broadband piezoelectric force excitation, especially at high frequencies.

Further work will include investigation of the connection of the force exciter and extension of the frequency range to lower frequencies. In addition, future work will focus on the acquisition of rotational degrees of freedom in the higher frequency range. ■

FE model correlation of a blisk

3D scanning laser Doppler vibrometry for fuel-efficient turbines

Fuel consumption of aircrafts is a hot topic in the current discussion about global climate change. An important factor is the design of the aircraft engine itself. In order to reduce weight and build more economic engines, the use of blade integrated disks (blisks) is getting more widespread. These components are milled from one single piece instead of being assembled like conventional parts.



NEED FOR VIBRATION TESTS AND MODEL CORRELATION

Blisks reduce weight and complexity, but bring technical challenges. As they are made from one single piece, they show extremely low damping, leading to very sharp, pronounced vibration resonances. An ideal blisk is symmetric, meaning that all sectors have the same geometry and material properties. In such a case, the vibration modes show a symmetrical behavior as well, the vibration energy is distributed equally among all sectors. Very small imperfections in the manufacturing process lead to mistuning of the resonances. If mistuning appears, the vibration energy might be concentrated in one or a few blades, leading to high vibration amplitudes. During operation, this could lead to higher stress and ultimately to an earlier failure of the component (high cycle fatigue). To predict the real stresses under operation, detailed Finite Elements (FE) modelling is needed. As a first step, a FE model for a symmetric part needs to be validated by test. As a second step, it will then be adapted to account for the observed mistuning. Detailed FE correlation is therefore a crucial step and needs to be performed very accurately.

3D LASER DOPPLER VIBROMETRY FOR MODEL CORRELATION

Laser Doppler vibrometers measure the vibration behavior reliably in a non-contact manner over the entire needed frequency range. No mass loading or increased damping as for conventional contact sensors like accelerometers appears. This is a mandatory condition for an accurate and detailed model correlation. 3D Scanning Laser Doppler Vibrometers (3D SLDVs) furthermore yield the complete 3D deflection shapes for all frequencies in a simple and accurate way, leading to a full dataset that can easily be used for correlation with FE models.

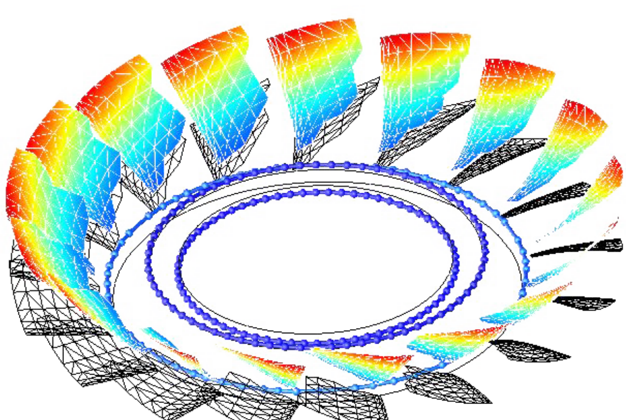


Figure 1: Measurement setup of a 3D Scanning Laser Doppler Vibrometer on a blisk of 240 mm diameter

A compressor blisk of 240 mm diameter, provided by the ITSM from the University of Stuttgart is studied. It is manufactured out of stainless steel and has been milled with high precision at a company specialized in the manufacturing of these parts. A high-resolution geometry scan showed only very slight geometrical deviations, in the order of 50 µm. The blisk has been placed on three small rubber pads, to decouple the part from the environment, while minimizing the influence from the support. Broadband excitation up to 20 kHz is performed by a SAM 1 Scalable Automated Modal Hammer. The 3D SLDV, type PSV-500-3D Xtra, is using an infrared light source of 3 mW power, removing the need for elaborate surface preparation and still being eye-safe. ▶

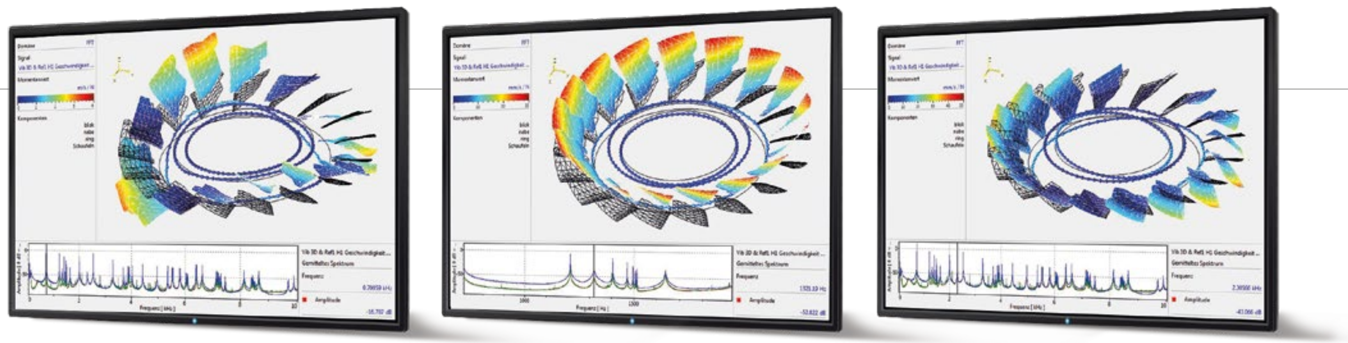


Figure 2: Selected deflection shapes of the blisks transfer function spectrum at 0.7 kHz, 1.3 kHz and 2.3 kHz from left to right (see below)

RESULTS

Figure 3 shows the measured transfer function (FRF) spectrum, averaged over all scan points, figure 2 some example deflection shapes. Figure 4 exemplifies a frequency split of the double modes, characteristic for cyclic-symmetric structures, giving the first hint at a very slightmistuning of the blisk, an important parameter, see above.

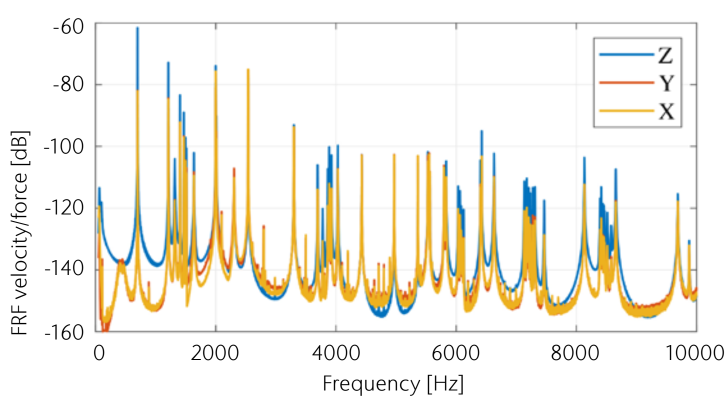


Figure 3: The blisks transfer function (FRF) spectrum

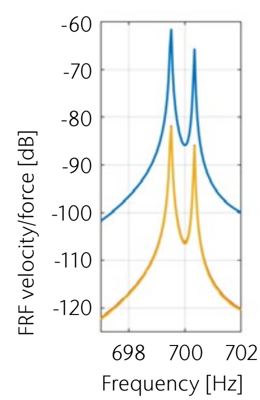


Figure 4: FRF spectrum showing a slight frequency shift between two symmetric modes

For further analysis and comparison with FE, the dataset is exported as a universal file and modal extraction is performed, using the modal analysis software package PolyWave. The modes of the first mode family so-obtained are then compared to the modes from FE simulation for a purely symmetrical structure. Table 1 shows the frequencies from test and simulation, their differences and the damping ratio, obtained from the test. Data is shown for the first mode family, where all individual blades show the same first-bending-type deflection shape. The frequencies are in excellent agreement, indicating that the mistuning is small. Nevertheless, the slight split in the frequencies of the double modes (0.6 - 3 Hz, for center frequencies of about 1 - 2 kHz) shows that it is present.

Mode	$f_{FEsim.}$ [Hz]	$f_{measured}$ [Hz]	Δf [-]	$\xi_{measured}$ [-]
1	701.8	699.5	0.3%	2.8×10^{-5}
2	701.8	700.3	0.2%	2.8×10^{-5}
3	1216.0	1212.1	0.3%	3.4×10^{-5}
4	1216.0	1212.7	0.3%	3.0×10^{-5}
5	1300.4	1320.0	-1.5%	1.5×10^{-5}
6	1408.9	1405.8	0.2%	3.1×10^{-5}
7	1408.9	1406.5	0.2%	2.8×10^{-5}
8	1471.9	1469.2	0.2%	2.8×10^{-5}
9	1471.9	1469.8	0.1%	2.4×10^{-5}
10	1498.0	1495.1	0.2%	2.8×10^{-5}
11	1498.0	1496.0	0.1%	2.8×10^{-5}
12	1510.0	1508.3	0.2%	2.8×10^{-5}
13	1510.0	1508.3	0.1%	2.7×10^{-5}
14	1514.8	1512.9	0.1%	2.7×10^{-5}
15	1514.8	1515.0	-0.0%	2.7×10^{-5}

Table 1: Comparing damping ratio of simulation and test results

This is consolidated by comparing the mode shapes extracted from test with those from FE with a MAC analysis shown in figure 5. As usual, MAC values close to 1 indicate high similarity of the mode shapes, smaller values indicate deviations in mode shape. While the lower order modes show excellent correlation, some of the higher order modes show lower MAC values. A more detailed study (see references below) shows that these deviations in mode shapes can very well be explained by slight geometrical mistuning effects, which break the symmetry of the mode shapes by localizing the vibration amplitudes to a few blades more than to the others.

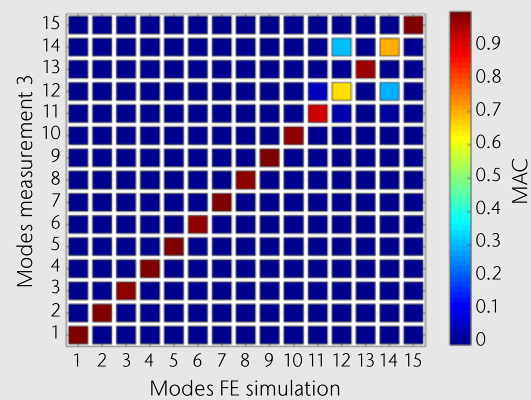


Figure 5: MAC values of modes from measurement vs. FE simulation

CONCLUSION AND OUTLOOK

3D laser Doppler scanning vibrometry is an excellent method for acquiring high fidelity data from challenging objects like blisks. Modal extraction of the data using PolyWave enables a detailed correlation with FE modes. The results from simulation and test in general turn out to be very congruent, all relevant modes from simulation can clearly be detected and the agreement in terms of frequency is very good. A detailed analysis of the data shows slight mistuning effects in the manufactured blisk, which was not captured by the FE model for the idealized of the CAD model. These mistuning effects can be detected by frequency splits of double modes and also by differences in the mode shapes of higher order modes, indicating localization effects of the vibration energy. The results allow for an FE model update, that takes into account mistuning, which is mandatory for predicting the high cycle fatigue under real operating conditions. So far, the analysis has been limited to the modes of the first mode family of the blisk, but as data has been acquired up to 10 kHz, also higher mode families can be studied at the same level of detail. ■

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Patric Buchwald et al.
Paper presented at the APVC conference in Sydney, Australia, Nov. 2019.

Using disrupting noise to combat insect pests without poison
Laser vibrometry is the key

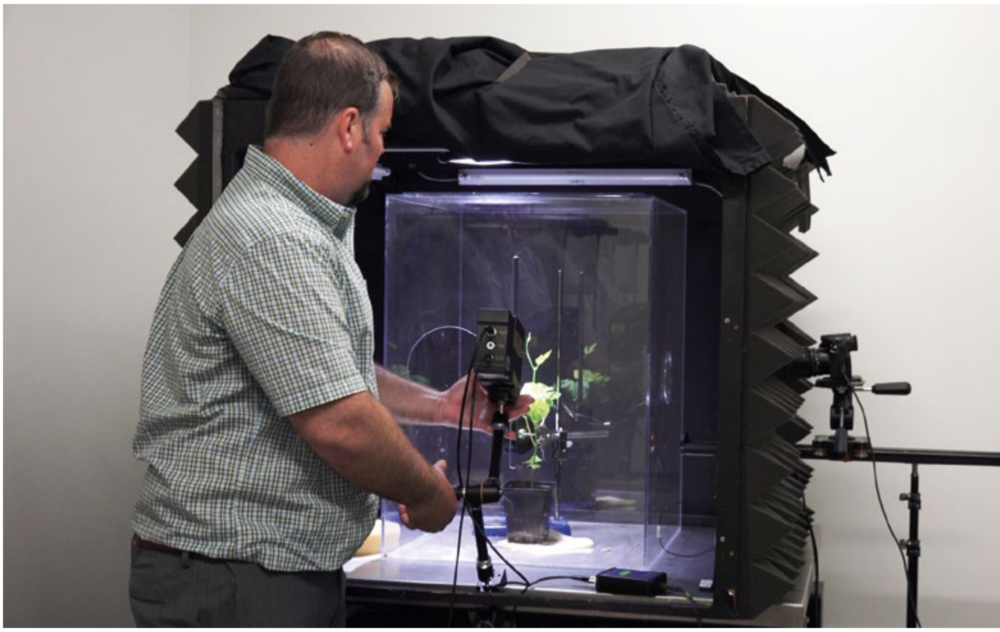
The bacterium Xylella fastidiosa causes various serious diseases in a large number of crop plants. Among other things, the plant pathogen is responsible for a devastating disease in grape vines in California and South America, which costs the Californian economy alone around 104 million USD every year. In a unique research project, scientists analyzed the courtship communication of insects with the aid of optical laser vibration measurement – and found a new method of control that has no adverse affects on the ecosystem, unlike existing measures such as the use of pesticides. This creates hope and optimism for farmers in Europe, where the bacterium has been spreading since 2013.

The team of researchers at the United States Department of Agriculture (USDA) headed by entomologist Rodrigo Krugner has declared war on the Xylella fastidiosa bacterium in Californian vineyards. The bacterium causes severe plant diseases, such as olive quick decline syndrome in Italy or citrus canker in Brazil. The grape vines in the USA and South America suffer from Pierce's disease, which blocks the supply of water and nutrients inside the plants. The plants then die completely within three years. The research team identified 13 insect species as vectors, i.e. carriers, including the glassy-winged sharpshooter (GWSS), a small cicada species measuring approximately 1 cm. The GWSS is a particularly dangerous vector, since it can fly long distances and the bacterium spreads in the surrounding areas extremely quickly. Pesticides have been used to contain the GWSS population for over 25 years. However, the recently increasing tolerance of the leafhoppers to the sprayed pesticides has forced researchers to explore new methods.

LASER VIBROMETERS IN ENTOMOLOGY

The GWSS has a complex communication system. It generates sounds by vibrating its body, thereby transmitting vibrations through the plants. The insects perceive the signals of others of its kind via sensory organs in the legs. The insects also communicate via vibrations transmitted through plants when searching for a mate. "These are frequencies and vibrations transmitted to the plant that we cannot hear without ▶

The portable vibration measuring technology is suitable for both laboratories and field studies – here during tests for disrupting the communication of the cicada



specialized equipment", explains Rodrigo Krugner.

The idea of the research team was to first decipher these frequencies and vibrations, in order to find an approach to prevent or disrupt them: "The approach is to disrupt communication of the insect. The first step is to identify and describe their mating calls. We also look for weak links in their communication system. These are the places we are going to try to interfere with", says Krugner. The researchers used a portable laser vibration sensor from Polytec to acquire and analyze the frequencies.

MOBILE VIBRATION MEASUREMENT FOR LABORATORY AND FIELD STUDIES

The stand-off distance of the compact vibrometer can be varied from 0.4 to more than 20 meters, and the power consumption is low, which makes it particularly useful for biological sampling – for laboratory analyses and for field tests directly in the vineyards. The current version of the portable, self-contained laser vibrometer optically measures the vibrational velocities of objects in the frequency range from DC to 100 kHz and therefore without contact. The housing is hermetically sealed, and the construction is robust and lightweight. It is explicitly designed for vibration measurements that require portability. The portable vibrometer can optionally run battery-powered, has an innovative interface concept and is compatible with common data acquisition systems: It is the ideal tool for non-contact inspection of machines as well as for studying biological samples. It can be used in the presence of strong electromagnetic fields or in other danger areas, as well as for research in remote areas such as forests and wilderness.

The researchers succeeded in acquiring the duration and spectral parameters of the various sounds and managed to analyze and allocate them to the individual courtship participants. They identified the vibration frequencies of the calling female, the courting male and the signals of rivals in the courtship communication. The behavioral and signal analysis enabled the researchers to isolate what they called "candidate disrupting signals", which disrupted the courtship communication of the actual pair, thereby preventing mating. The team ensonified the insects with the recorded disrupting signals, in order to inhibit mating.

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Watch the video

RESULTS AND FUTURE PROJECTS

The method is already showing promising results in the laboratory: Of 134 GWSS pairs, 28 pairs mated in the control group that was not ensonified. Of the 134 pairs that were ensonified with the disrupting signals, only one pair mated. The new method has also proved its worth in the field, as Kruger summarizes: "We took the playback sounds out into the field and were able to disrupt mating of virgin insects in vineyards."

The method can be combined with existing measures such as the area-wide application of insecticides or the mass distribution of natural enemies of the pests. In contrast to the use of toxic spray or exotic predators, ensonification only combats one specific species and has no impact on the native beneficial insects. The communication frequencies of the GWSS are also specific to the cicada species.

The innovative and environmentally friendly approach and the existing data give grounds for optimism that the USDA has been able to develop a method with a high potential for success, in order to contain more than just the GWSS population. The task now is to determine further and more comprehensive data and to optimize ensonification at the vine espaliers. The further away the signal source, the lower the frequencies and the lower the disruptive effect on the insects. The research team also plans to analyze other vectors of Xylella fastidiosa and other plant diseases with the aid of optical vibration measurement.

Non-contact inspection of coated surfaces by white-light interferometry

For permanently high screw pre-tensioning force and optimum corrosion protection

Polytec

The surface properties of coatings and paintwork play an important role in many products, as they have a significant impact on visual appearance, corrosion protection and resistance to physical damage. Information about the surface flatness or surface deformations due to mechanical stress is the basis for optimization. This information can be used to better control friction, minimize wear, increase resistance against external influences, improve conductivity, determine quality parameters for future paint finishes or examine the limits of certain coating procedures for screw connections. Optical measuring methods are used here as non-contact and non-destructive analysis and testing methods on almost all materials – especially for sensitive surfaces.

Prof. Dipl.-Ing. Alfred Isele and his team at the Faculty of Mechanical and Process Engineering at the University of Applied Sciences Offenburg, Germany are investigating the impact of organic corrosion protection systems and other coatings on screw connections. The motivation for this is the longevity of the tested components and their connections. These should subsequently function reliably over the entire service life, usually twenty years or longer under harsh environmental conditions, installed in machines, automobiles, heavy duty machinery or e.g. wind turbines. The screw connection of components must therefore be permanently tight but must also not damage the surface coating or paintwork on contact surfaces, in order to obtain the requisite corrosion protection.

CORROSION PROTECTION COATINGS EFFECT SCREW CONNECTIONS

"Connections between uncoated components behave differently than those between painted components," says Professor Isele pointing out the fundamental difference. Metallic surfaces are in direct contact without an intermediate layer, and the screw connection compresses the intermediate layer in painted components. This results in small deformations in the µm range, which nevertheless have a vital impact on the connection. This impairs the quality of the connection, i.e. the holding force of the screw, over many years of use and corrosion protection. ▶

Prof. Dipl.-Ing. Alfred Isele

The University of Applied Sciences Offenburg, Germany is investigating the behavior of the surface at these connection points, as well as the changes in pre-tensioning force and deformations that occur under certain conditions (figure 1), in order to determine limit values such as temperature or load level.

NON-CONTACT SURFACE METROLOGY IS THE KEY

The commonly used profile method is a tactile surface measurement method with diamond probe elements. “Unfortunately, this method has two disadvantages for our testing”, says Prof. Isele regretfully. “The point-by-point tactile measurement is quite slow and we only get one sectional image per measurement. However, since a corrosion protection coating is subject to application-related layer thickness fluctuations, a single cross-sectional image is not sufficient for quantitative evaluation. We therefore need a measurement procedure that allows surfaces to be measured completely. In addition, the tactile profiling method has the disadvantage that the geometry of the probe and the sample surface are always subject to a certain amount of wear.”

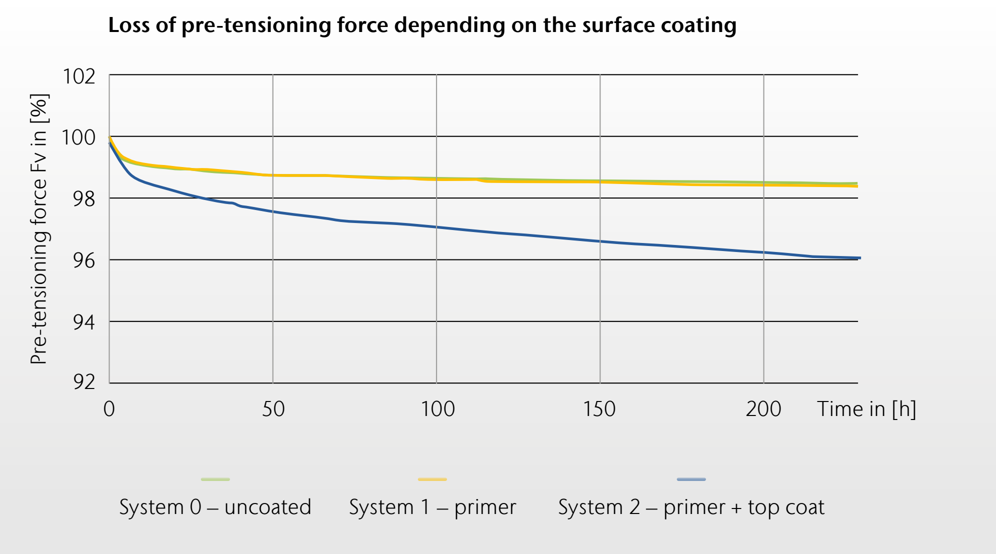

Figure 1: The loss of pre-tensioning force decreases depending on the surface coating.

On the other hand, optical methods such as white-light interferometry perform large-area surface inspections without contact and wear, enabling short measurement times and high reproducibility.

TopMap measuring systems from Polytec also offer a very high vertical resolution, independent of the field of view. Additionally, Polytec TopMap solutions with telecentric optics allow to acquire large areas and thus more details with a single view without stitching (merging of measurement areas) (figure 2).

EVERYTHING IN VIEW THANKS TO WHITE-LIGHT INTERFEROMETRY

The white-light interferometers of the TopMap series offer a large vertical travel range and nm resolution in the non-contact measurement of flatness, step heights and parallelism. The telecentric optics can even measure steep steps, such as those found in drill holes. “We were also impressed by the ease of operation and the user-friendly evaluation options”, adds Prof. Isele. The open software

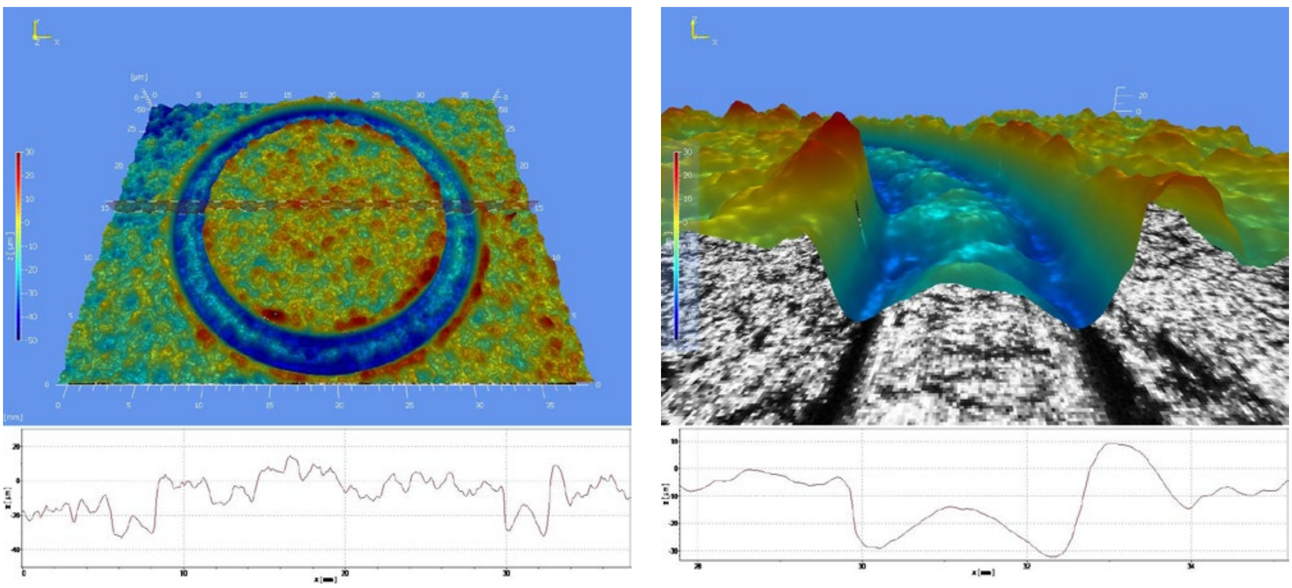

Figure 2: Non-contact recording of roughness profiles as a quality indicator for paint quality and appearance, on large areals on the left and as cross sections on the right (copyright: University of Applied Sciences Offenburg)

architecture also makes it possible to program routine tasks or set up your own user interface.

However, the measurement system is not only suitable for laboratory areas, but can also be used in production. This measurement technology is integrated in a dust-proof and vibration-damped test station and is operated directly in machine shops e.g. along the sheet metal production chain in the automotive industry: The high-quality appearance of a vehicle depends largely on the paint quality. TopMap can supply characteristics for checking the appearance along the entire painting process and before the final inspection. Here, the surface roughness determined over a large area serves as a quality parameter for the paint quality and the subsequent appearance. ■

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www.polytec.com/us/surface-metrology

One-box solution for laser vibration analysis

VibroOne

The Polytec VibroOne laser Doppler vibrometer is the one-box solution for non-contact vibration measurement. With VibroOne you analyze acoustics, dynamics and vibration issues in both R&D and industrial quality control with laser precision. VibroOne comprises an all-in-one front-end with integrated laser and a fiber-coupled, compact sensor head. Integrated with the VibroLink digital interface and the VibSoft data acquisition and analysis software, this vibration measurement system is ready to point, shoot and measure in an instant.

VibroOne is specifically designed for tightly packed setups, whether in research laboratories, challenging production environments or for non-contact analysis of tiny details on microstructures or biomedical probes. The optional inline HD+ camera helps positioning the laser precisely and provides proper test documentation. An optical filter adjusts for a perfect contrast of the laser spot. Optional microscope lenses focus to a 1.5 µm laser spot, even allowing the inspection of fine details.

The all-in-one laser vibrometer VibroOne allows measuring frequencies on a large bandwidth from DC up to 3 MHz with highest time resolution. The measurement system offers analog outputs for measuring displacement, vibrational velocity and acceleration synchronously. The digital VibroLink interface provides a convenient, fully digital transfer of the measured velocity signal via Ethernet to a notebook or computer. Thus it allows a comfortable and powerful analysis in time and frequency domain with the Polytec VibSoft data acquisition and analysis software with the best signal-to-noise-ratio (SNR). Thanks to its analog BNC signal outputs, VibroOne is also compatible with conventional data acquisition hardware.

Find further information:
www.polytec.com/vibroone

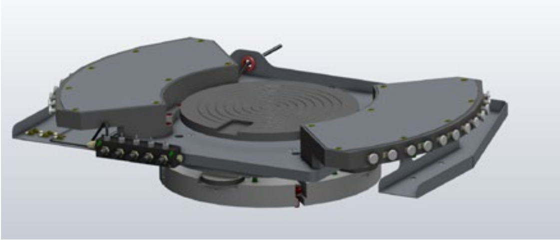
Polytec

MEMS inspection up to the UHF range

MSA-600 X/U Micro System Analyzer

Find further information:
www.polytec.com/msa600

MEMS, BAW and SAW (bulk / surface acoustic wave) filters are the micro components that make our smartphones, electronics and control elements in cars even smarter. For the test tasks of high-frequency technology – from development to production and quality control – the MSA-600 Micro System Analyzer now offers new high frequency versions to scan up to 2.5 GHz bandwidths in order to test component dynamics and topography in a non-contact, high precision and even ultra-high frequency manner. Visualization of dynamic response and static characterization are key to testing and developing MEMS devices. They are important for validating FE calculations, determining crosstalk effects and measuring surface deformation. Polytec's new MSA-600 Micro System Analyzer is the all-in-one optical measurement workstation for characterizing surface topography as well as in-plane and out-of-plane motions. This instrument delivers measurement flexibility and precision, adapting to the testing needs of today's and tomorrow's microstructures.
Its primary function is the real-time characterization of out-of-plane (OOP) vibrations by laser Doppler vibrometry to frequencies up to 2.5 GHz and with a displacement resolution down to the (sub-)picometer level. You can identify, measure and most of all clearly visualize system resonances and transient responses.
The planar motion analysis means a characterization and live-mode visualization of in-plane motion by stroboscopic video microscopy to frequencies up to 2.5 MHz and with a displacement resolution in the nanometer range. Gather detailed information about the amplitude and phase.
Last but not least, the surface topography option allows a 3D surface profiling by scanning white-light interferometry. With a vertical resolution down to sub-nanometer and a horizontal resolution in the sub-micrometer range, you obtain 3D profiles and determine surface and form parameters in no time.



New accessory: 200 mm wafer prober module

Laser vibrometer to go

From R&D to condition monitoring of industrial plants

Non-contact laser Doppler vibrometry, originally developed for vibration analysis of structures under R&D and laboratory conditions, has proven extremely useful in diverse applications ranging from the investigation of biological structures to in-situ industrial equipment monitoring. Today, industrial and research applications benefit equally from non-contact metrology. Technical innovation has further extended the areas of application. A new, extremely lightweight vibrometer, designed explicitly for portable use, enables the measurement of vibration displacements, velocities, and accelerations of any object in a frequency range up to 100 kHz even at distances up to 30 m.

Laser Doppler vibrometry is a robust measurement procedure. It uses a basic principle of physics – the frequency of the light reflected from a moving object changes in proportion to its speed. This effect, known as the Doppler shift, also applies to reflected light coming from vibrating surfaces. The velocity information of the vibration is encoded in the frequency shift, which is used as a measure of the vibration. A precision interferometer combined with digital decoding electronics converts this frequency shift into a voltage signal. Since the velocity information does not depend on the light intensity, the process is suitable for objects having very low reflectance. Furthermore, since the probe is a beam of light, there is no mass loading of the test object, making laser vibrometry the idea tool to characterize objects where attached sensors would significantly change the measured results.

PORTABLE HIGH-TECH FOR OUTDOOR USE

Laser vibrometry has matured, making mobile applications possible. To satisfy the mobile applications market, Polytec developed the compact, battery-powered VibroGo – a vibrometer that weighs about 3 kg and transports easily. It has a robust design, making it suitable for tough outdoor use. This portable vibrometer has a lot to offer: the VibroGo can be conveniently set up and configured via the 5-inch color touchscreen with intuitive menu navigation. In addition to the autofocus function, the touchscreen can manually control the focus. With a bandwidth of up to 100 kHz, this range can cover most acoustic and dynamic measurement tasks. Compared to the predecessor, the optical sensitivity could be further increased with the VibroGo, providing excellent measurement data quality in almost all its measurement tasks. Object measurement speeds of up to 2 m/s are possible. Furthermore, vibrational velocities, as well as vibration displacements and accelerations, can now be measured at distances of up to 30 m. For further processing, the measurement data can be

Figure 1: Condition monitoring: Industrial installations and components can be monitored from a safe distance without contact including locations where fixed sensors cannot be mounted, e.g., hazardous areas.

Figure 2: Portable laser vibrometers are the vibration measuring instrument of choice for botany, entomology, bionics, and even pest control

transferred to a laptop or computer through an analog connection or digitally via Ethernet or wireless LAN.

DIVERSE APPLICATIONS IN INDUSTRY AND NATURE

There are many applications for portable vibrometers. The condition monitoring of industrial and factory floor equipment is one of them. Periodically specific industrial components can be safely and remotely monitored from a distance without contact, even in locations where fixed sensors cannot be mounted. There are many relevant examples, including pumps and pipelines (figure 1), high-voltage components and hot surfaces or other hazardous environments. The VibroGo is more than an industrial tool. Its portability and accuracy unlock interesting possibilities for scientists studying in many fields. In entomology, the mechanical properties of spider webs can be studied, and their response to wind-induced vibrations and the high impact energy of flying prey can be measured. A mobile vibrometer, positioned in the jungle near the web, measures the in-situ damping properties of the silk threads to predict the vibration characteristics of a complete spider web. The laser vibrometer is an essential tool for characterizing such structures since the thread structure cannot bear the load of conventional sensors such as accelerometers and strain gages.

Portable vibrometers like the VibroGo are the preferred method for characterizing insect vibrations, even for pest control (figure 2). In a unique research project, scientists used laser vibrometers to analyze the courtship communication of the glassy-winged sharpshooter (a distant relative of the cicadas). These insects spread a certain bacterium that is very harmful to some plants, more specifically to vines. They ultimately found a new ecologically safe method of pest control which has no adverse effects on the ecosystem, unlike previous measures such as the use of pesticides.

For universities that want to give their students an understanding of laser Doppler vibrometers and their application to novel measurements, Polytec offers an education kit. This kit includes practical experiments and provides an exciting introduction to the world of optical vibration measurement.

Find further information:

www.polytec.com/vibrogo

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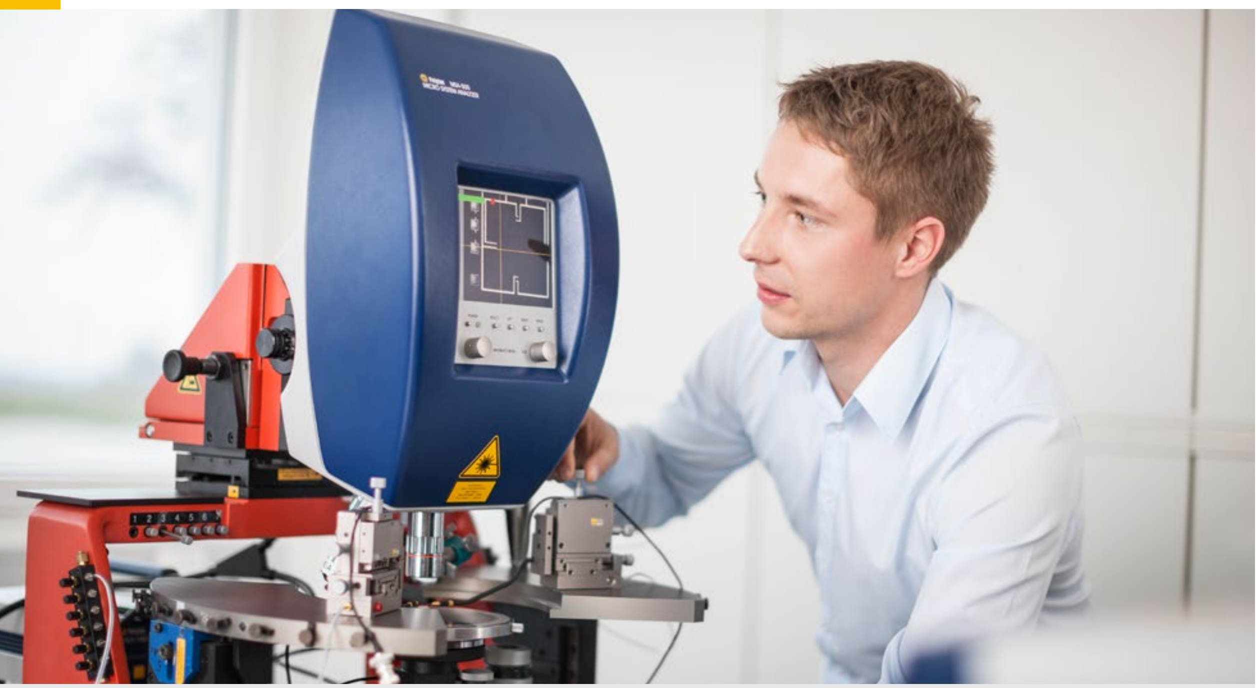

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