SPECTRUM

News from Quantum Design Europe

Edition 39 | December 2022

We Keep Science Running – Merck Corporate Run in Darmstadt

After a seemingly endless break of almost two years due to the pandemic, the Merck corporate run in Darmstadt took place again this year. To us, it was no question that we would definitely take on the challenge and participate in this event again. So we worked out an appropriate outfit to create a uniform look, and some of us may also have done some training in preparation of the run...

A total of 4715 running enthusiasts turned up to participate. Everyone could choose their running distance between 3.33, 6.66 or 9.99 km, circling the Darmstadt "Messplatz" square. Despite the great heat, all of our 20 runners, distributed over all starting groups, were lucky enough to reach the finish line. Indeed, it was a super hot day, with the heat coming from

» Page 2

FusionScope

Open a World of Easy-to-Use Correlative Microscopy by combining SEM with AFM in All New Ways

FusionScope is an easy-to-use correlative microscopy platform designed from the ground up to provide the benefits of SEM imaging together with a wide range of AFM measurement techniques. Combine SEM information with three-dimensional topography, the characterization of nano-mechanical, conductive, and magnetic properties, and much more.

FusionScope uses an innovative shared coordinate system to automatically align AFM and SEM operations

for measurements and sample positioning. Within a single software interface, you can easily identify your area of interest, measure your sample, and combine your imaging data in real time.

» Page 3

Content

Quantum Design
EUROPE

We Keep Science Running – Merck Corporate Run in Darmstadt

» just everywhere, emanating from the asphalt and creeping up towards the brave runners. Of course, the organizer was prepared. All along the way, abundant drinks were provided and the local fire department even refreshed us with a cooling shower from above.

Having passed the finish line, a warm welcome awaited us and we were treated to plenty of food and drink. The approaching thunderstorm did not keep us from having fun at the party. What a pity that eventually, we had to leave early due to lack of shelter against the rain.

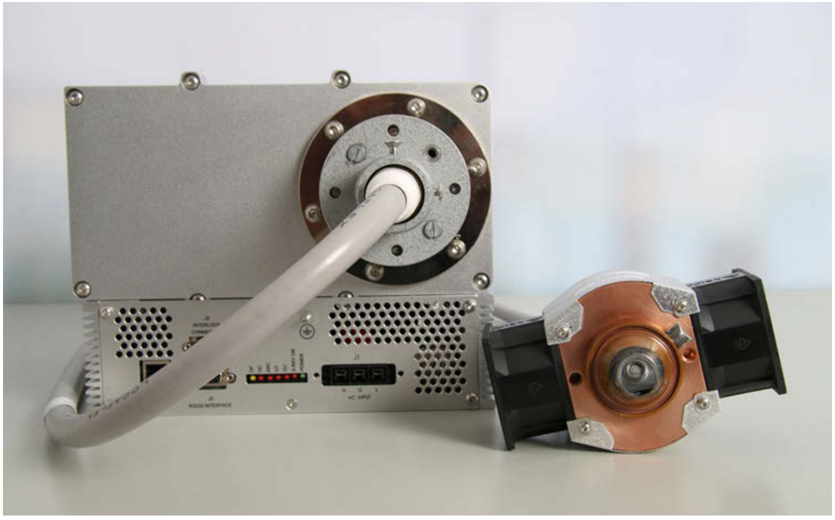
Overall, it was a successful event that strengthened the team spirit. We are happy to have been a part of it!

Please contact us
spectrum@qd-europe.com

NewHigh Power X-Ray Sources for XRF and Imaging Applications

The HPC high power tubes are designed to be used in XRF and imaging applications. As "targets", tungsten and molybdenum are available.

10-75 kV range with constant power consumption up to 350 watts. The tube is air cooled and the "push/pull" configuration enables the warm air to be guided to the outside.


HPC High-power tube with power supply

For XRF applications, the cone is vacuum-sealed at the base. The HPC tube incorporates radiation shielding.

Typical applications are, e.g.:

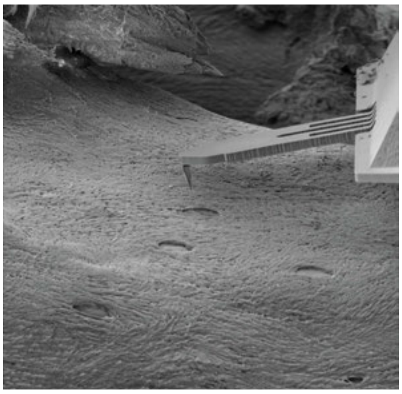
- Food inspection
- Thickness gauging
- Scrap metal recognition and sorting

Please contact us
imaging@qd-europe.com

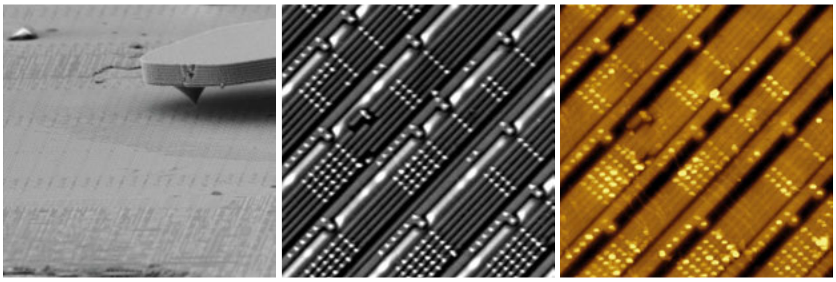
The FusionScope - correlated microscopy completely rethought

» New users will find correlative microscopy easy and accessible, while experienced users will be equipped with a powerful tool that contains the SEM and AFM functionality, they are familiar with. With Profile View — an 80-degree tilt of the combined sample stage and AFM scan head — you can position the AFM tip quickly and precisely, even on complex and challenging sample surfaces.

Our team from Quantum Design at MNE 2022 at the launch of the new FusionScope.


Profile View with the FusionScope from a bone surface

Focus on your research and let FusionScope do the rest. FusionScope's software provides an intuitive and customizable user interface and integrates automation of most functions into helpful workflows. Intelligent data handling organizes all your SEM and AFM data for easy access in the future. Use the FusionScope for detailed Material Characterization of your samples and perform correlative analysis of their structural, mechanical, electrical, and magnetic properties on your exact region of interest. Carry out high-level Quality Control of component parts or perform Failure Analysis on electrical components or semiconductor devices as you benefit from FusionScope's fast and intuitive workflow. Easily characterize Nanostructures such as nanowires, 2D-materials, and nanoparticles. FusionScope gives you full control to locate your area of interest, position your probe, and perform a wide range of measurements.


(Left) Profile view of CPU chip and cantilever. (Middle) SEM image of CP chip (Right) AFM image of CPU chip

Interested? Learn more about the specific details of the FusionScope on our new website: www.fusionscope.com

Please contact us
germany@qd-microscopy.com

Microwriter at the UPVfab in Valencia

To complete the lithography line of its microfabrication facility UPVfab, the Spanish University "Universitat Politècnica de València" has acquired a MicroWriter 3 Pro direct-write photolithography system. The microfabrication line includes 500 m2 of ISO-7 clean rooms (class 10 000) and positions equipped with automation tools for backend processing of semiconductor wafers. As part of a strategy to equip the microfabrication facility in the technical disciplines of photonics, electronics and chemical engineering, the new equipment has been funded by the Regional Government Generalitat Valenciana, within the framework of the project GVA/IDIFEDER/2021/046 "Multi-level Microfabrication Technologies (T-MFAB-MN)".

For further information, please contact:

UPVfab
- Dr. Gloria Micó
- Facility Manager, UPVfab Microfabrication Facility,
- Universitat Politècnica de València
- Phone: +34.963.879.760
- Mail: gloria.mico@upv.es
- https://www.fab.upv.es/

Please contact us
materials@qd-europe.com

The Sun in the Light of the Hα Hydrogen Line

The sun is our star in the daytime sky and, in addition to supplying us with light, heat and life, it also provides us with a number of spectacular phenomena that we can study with the help of special solar telescopes. In the visible light of electromagnetic radiation (at wavelengths of about 400-780 nm), for instance, sunspots can be observed (see Fig. 1, left). These are regions of increased magnetic activity that inhibits the supply of heat via convection from the interior of the sun. As a result, these regions are about 1500°C cooler than the surrounding environment with a temperature of approx. 5000°C, the so-called photosphere, which is the lowest layer of the solar atmosphere.

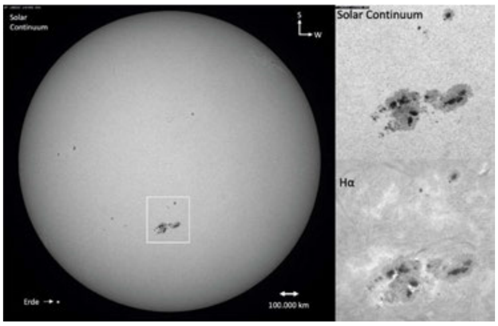


Fig.1: Left: The photosphere of the sun in the green light of the visible range - image taken with a Baader Solar Continuum filter (535-545 nm) on 19 May 2022 from the astronomical observatory in Meckesheim, Germany Top right: Close-up of a large sunspot group in green light. Bottom right: Detailed image of the chromosphere in the light of the Hα line at 656.3 nm with the configuration from Fig. 4. The filament-like structures in the region of activity, which are caused by the gas eruptions in the magnetic field of the sunspots, are clearly visible. The bright regions in between the sunspots (so-called solar flares) are regions that are particularly hot and active.

Frequently, gas eruptions occur in these regions of activity. These prominences radiate in the red light of the Hα line at 656.3 nm. Unlike sunspots, they cannot be observed in the entire visible range since they are literally outshone by the photosphere. Only during a total solar eclipse can the solar limb including prominences be observed for a few seconds. During such a phenomenon, it is actually possible to examine the chromosphere with the naked eye. The chromosphere is the gaseous layer of the sun, which is adjacent to the photosphere and is about 2000 km thick. Compared to the solar radius of almost 700,000 km, however, this is not much.

To be able to study prominences and other interesting phenomena of the chromosphere of the sun not only during a solar eclipse, refractors with special filters are widely used today: The brightness of the solar image is reduced by a block filter (band-pass filter). To isolate the Hα line, etalons are usually used, which eliminate most of the radiation in the visible light by destructive interference, only allowing wavelengths around 656 nm to pass (see Fig. 2).

At Meckesheim Observatory, the sun is observed regularly, since it has not yet been found out when, how and why all these phenomena in the solar atmosphere occur. Regular observation of the spatial and kinematic changes associated with solar phenomena can provide more data for testing physical models of complex magnetohydrodynamic processes, which might lead to a better understanding of the nature of our sun, which in many aspects is still mysterious.

Fig. 3: The "solar tower" of Meckesheim Observatory: With the two telescopes on the right, overview images of the sun can be taken in the range 535-545 nm and in the light of the Hα line as well as in the light of the Ca K line at 393.4 nm. The three refractors on the left are equipped with QUARK eyepiece filters and allow simultaneous images to be taken in the light of Hα (656.3 nm), Na D2 (589.0 nm) and Mg I b2 (517.3 nm). By using different filters, special solar phenomena can be studied at different stages of development.

Some of the acquired data is uploaded to central databases of astronomical associations and are thus available to interested amateurs and scientists.

Fig. 3 shows the observatory's so-called solar tower: an arrangement of five solar telescopes, enabling simultaneous images to be taken in four different bands in the visible range, with bandwidths from 0.04 to 10 nm.

Among others, an Hα QUARK eyepiece filter by Daystar is used This filter accommodates a 4.3x focal length

» Page 5

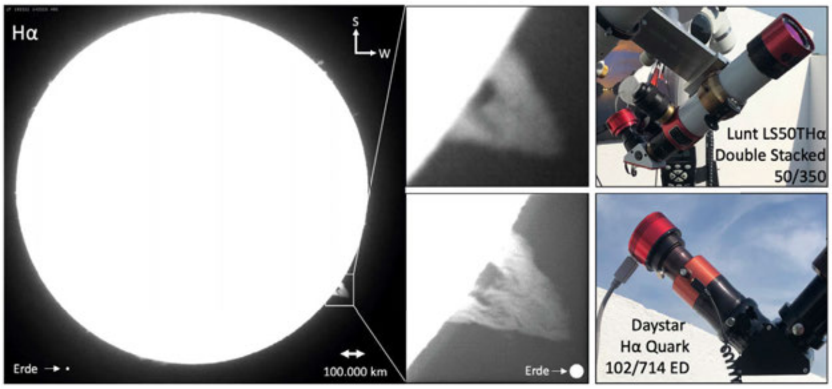


Fig. 2: Left: Overview image of the sun in Hα light - image taken on 19 May 2022 from Meckesheim observatory, using a Lunt solar telescope at 50 mm aperture and 350 mm focal length In order to make the faint prominences at the solar limb visible, the solar disk must be overexposed. Right: Detailed view of the prominence at 50 mm aperture and 350 mm focal length (top) and at 102 mm aperture and 3070 mm focal length - image taken with the configuration from Fig. 4. The resolution is much better, thus allowing detailed studies.

» extension, a 12 mm block filter and a 21 mm etalon. To adjust the wavelength, the etalon is heated with 1.5 A at 5 V via a power supply unit. An aperture system ensures stray light reduction and provides for high contrast.

Fig. 4 shows the setup for detailed studies of activity regions in Hα light on a refractor with 102 mm aperture and 714 mm focal length. The imaging is done using a monochrome astro camera, in which a Sony IMX174LLJ CMOS chip is installed and that delivers up to 120 frames per second. This allows air turbulence to be "frozen" to a large extent. Due to their higher resolution, monochrome cameras are preferred over color cameras.

Investigations in the light of the Hα line show changes in prominences, filaments, and flares over time scales of just a few minutes, while noticeable structural changes in photospheric phenomena (e.g. sunspots) cannot be be detected before several hours have elapsed. For this reason, Hα observations are of particular interest.

After more than 6 years of regular use, reduced contrast was observed in the imaging of activity regions of the chromosphere: Prominences on the solar disk, recognizable as dark filaments, were barely visible (see Fig. 5 above).

The reason for this was found quickly: The manufacturer's recommendation to put a UV-IR filter in front of the QUARK filter in telescopes with an aperture of 80 mm and larger had not been not complied with consistently. We now hoped that the etalon had not been damaged. Starting from the assumption that only the

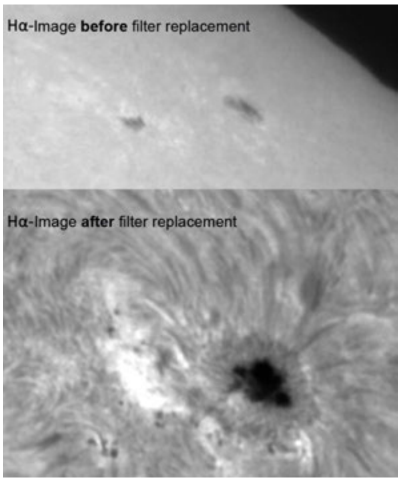


Fig. 5: An Hα image before and after replacement of the block filter In the bottom picture, the numerous appearing structures characterizing the solar activity are clearly visible.

block filter had been affected (see Fig. 6), we ordered a bandpass filter 656FS02-12.5 from Quantum Design.

With a CWL of 656.3 nm +0.2/-0 nm, an HWB of 1.0 nm ±0.2 nm at a transmis-

Fig. 6: The sunlight enters the filter system of the Hα QUARK eyepiece filter via this 12 mm bandpass filter (block filter), thus providing for dramatically reduced heat generation.

sion of at least 45% and a blocking of at least OD4, this filter meets the requirements for correct operation of the eyepiece filter. After this simple retrofitting measure, we noted with relief that the contrast in the image was as good again as it had been in the early years (see Fig. 5 below). Now, a permanently installed UV/IR filter in the optical deflection system prevents premature deterioration of the eyepiece filter system.

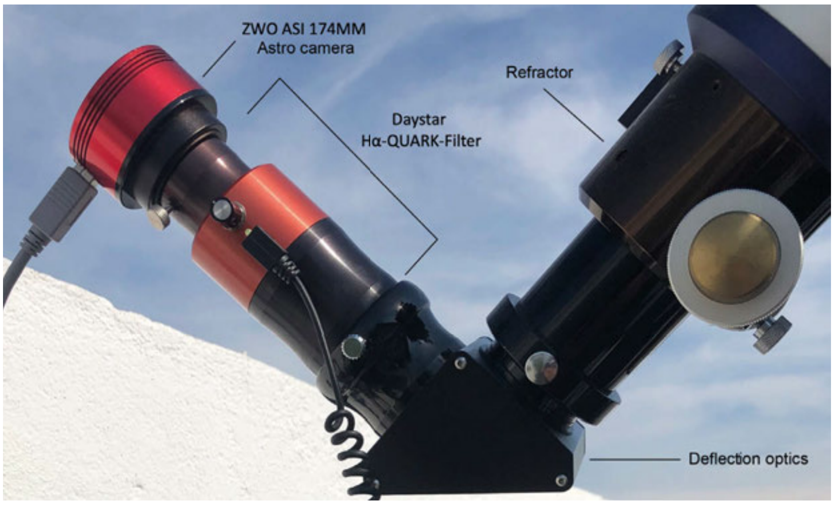


Fig. 4: Optical configuration for spatial and kinematic studies of solar chromosphere phenomena. Via an optical deflection system, sunlight from the refractor is guided through the Daystar Hα QUARK eyepiece filter. Here, imaging is done using an astro camera connected to a notebook.

- Dr. Gerhard Hirth
- Director of Meckesheim Observatory
- https://www.sternwarte-meckesheim.de

For more information, please visit our website.

www.qd-europe.com

Please contact us
optics@qd-europe.com

Marana-X-11 – Larger Sensor for EUV and Soft X-Ray Applications

Andor Technologies expands its portfolio with an uncoated, back-illuminated sCMOS camera for the soft X-ray range.

Building on its success with the Marana-X, Andor Technologies has added a large-format chip for direct X-ray detection to the Marana platform. With a 32mm sensor diagonal, this camera option responds to calls for a larger field of view, coming from scientists working in X-ray/EUV tomography and higher harmonics generation application areas.

Whereas in this energy range, slowly digitizing CCD cameras are usually still the option of choice, the Marana-X represents a significant technical advance especially for photon energies from 80eV to 1keV. In particular, its outstanding quantum efficiency coupled with deep thermoelectric cooling and low readout noise despite a high frame rate is unique. The Marana-X combines high sensitivity with high dynamics.

Another major advantage of sCMOS — compared with CCD technology — is the electronic shutter. This means that there is no need to use a vacuum-compatible mechanical shutter to prevent "smearing" of the image during the readout process.

For spectroscopic applications, data transmission to the PC can be optimized by vertical or even user-defined FPGA binning, as is the case with all cameras based on the Marana platform. The necessary data depth in such a scenario is enabled by the 32-bit data format.

Either a USB3 or a CoaXPress data interface may be used. This not only provides for easy integration of the experiment but also for reliable data integrity where measurement setups are connected over long distances.

As Antoine Varagnat, Andor's Business Manager for Physical Sciences, puts it:

"Marana-X 11 is a terrific addition to our growing portfolio of high-performance cameras. This latest detector is super-fast and sensitive, while it also benefits from a high dynamic range and high quantum efficiency, making it the optimal solution for direct soft x-ray and EUV imaging.

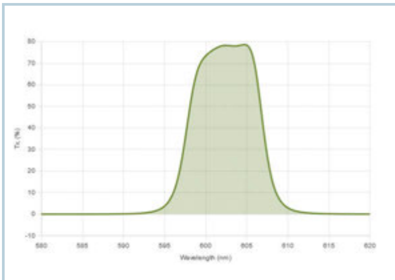
"With a drive to upgrade high energy physics sources worldwide, to higher fluxes and repetition rates, this innovative product will help scientists make the most of these advances."

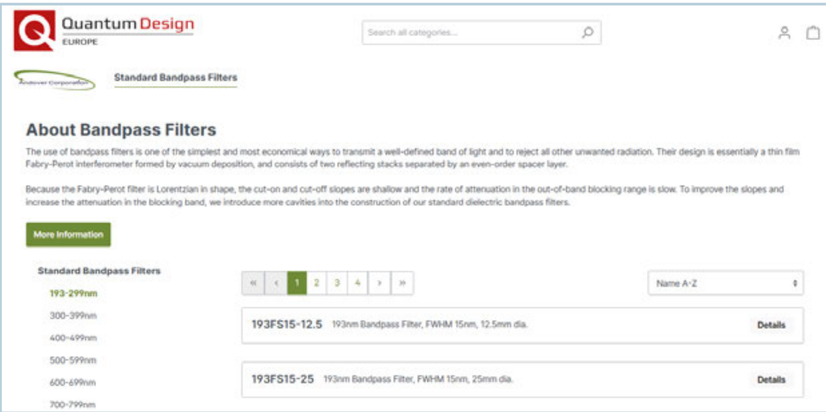
Please contact us
imaging@qd-europe.com

Web Portal for Inquiries for Andover Bandpass Filters

Andover offers a wide range of standard bandpass filters. To make it easier for you to select the right filter, we have set up a web portal. Here, you can see all filters in a clear layout. To automatically narrow the selection of filters shown, users can choose the specifications they are looking for. In the detailed view, you can see all specifications at a glance, together with the individual filter curves.

Thus, you can find the right filter with just a few clicks. Our automatic inquiry system will immediately forward your selection to the corresponding staff. We will then contact you and give you a quote.



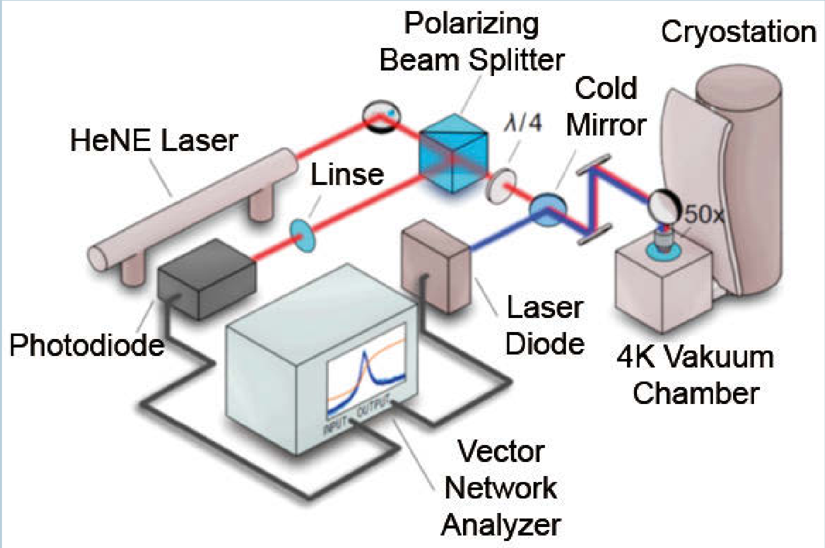


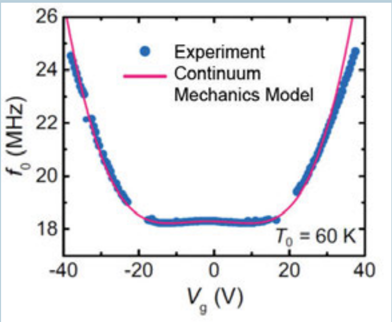
Please contact us
optics@qd-europe.com

Strain Tuning in 2D Materials – Nature

Various material properties, e.g. the Curie temperature, can be influenced by stretching and compressing the materials. The Curie temperature describes the temperature above which a ferromagnetic material loses its magnetization. An easy way that does not require a mechanical test setup is inducing strain via magnetostriction or application of a voltage.

Makars Šiškins of the Steeneken Team at Delft Technical University has published a spectacular paper on this topic in the journal Nature. In the paper, he describes how the resonant frequency of a 2D membrane (Cr2Ge2Te6-CGT) near its Curie temperature can be manipulated over a wide range. Embedding of a heterostructure prevents buckling and wrinkling that would normally occur in CGT membranes. The team has developed a method for studying magnetic properties almost at the level of individual layers, without interactions with the substrate distorting the measurement.





Thanks to to their low mass, high strength, and resonant frequency tunability, CGT membranes are promising candidates for sensor applications and nanoelectromechanical systems.

The team used a cryostation by Montana Instruments for their work. Due to its powerful vibration isolation, this special optical cryostat with closed helium loop has a vibration level of only a few nanometers in the sample chamber.

Source: npj 2D Materials and Applications (2022) 6:41

Please contact us
materials@qd-europe.com

May I introduce myself?

Hello, my name is Simon Wittner and since 2017 I am responsible for the product range of sample preparation for electron microscopy such as sputter coaters and critical point dryers in the service department of Quantum Design. Before I did my apprenticeship as a physics lab technician at Quantum Design (at that time still LOT-Quantum Design), I studied physics, education and educational sciences at the University of Koblenz-Landau on a teaching degree. Outside of work, I enjoy cycling a lot with my family in the nature of the Vorderer Odenwald. My tasks at Quantum Design include maintenance and repair of the offered devices of the company Quorum, installation and training at the customer's site in Germany and abroad, telephone and email support as well as finding individual solutions for the customer. You are welcome to contact me with your questions.

Please contact us
wittner@qd-europe.com

Chemical analysis of materials with high atomic numbers (Z) with our laboratory XAS system

X-ray absorption spectroscopy (XAS) is a powerful method for studying chemical states and the coordinated environments of selected elements. XAS has been commercially available for laboratory use for several years. In this report, we demonstrate the exceptional performance of Sigray's QuantumLeap H2000 for high-energy XAS on a Zr sample at 17998 eV.

Many laboratory XAS systems have difficulty at energies >12 keV due to increasing sagittal errors for Johann geometries at high energies. This is problematic because many important catalysts (Pt and Zr) and actinoids (U, Pu, Th, etc.) have L and K edges in the 12 to 25 keV range (see Fig. 1).

Sigray's QuantumLeap X-ray absorption spectroscopy systems are the first XAS laboratory instruments with synchrotron-like capabilities. The QuantumLeap systems combine several patented features, e.g.

- ultra-bright X-ray sources, the imaging technology and
- the system design

The QuantumLeap H-series is optimized for a wide energy range from 4.5 and 25 keV. In particular, the capacities in the high-energy range between 12 and 25 keV are of great importance for numerous nuclear applications as well as in catalysis.

Experiments and results

We have used the QuantumLeap on a Zr foil with a thickness of 7.5 µm to demonstrate the capabilities offered by the system in high energy X-ray near edge absorption spectroscopy (XANES) and X-ray absorption fine structure (EXAFS) analysis

Method

Using intuitive software, the K-edge of Zr was selected from the periodic table of the elements.

The system automatically selected the appropriate crystal — a cylindrically bent Johansson crystal Ge (800). An energy spectrum of 17.8-18.7 keV (wavenumber k=~13 Å^{-1}) was produced within seven hours (see Fig. 2). The XAS data were processed and analyzed using the Athena and Artemis programs of the IFEFFIT package [1].

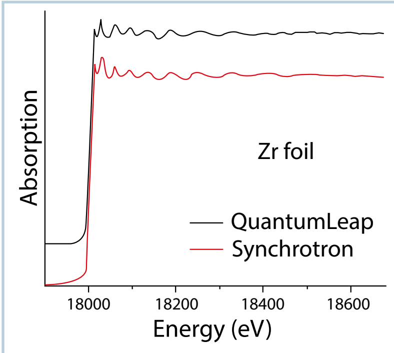


Fig. 2: Zr K-edge (17998 eV) XANES and EXAFS of a Zr film obtained with QuantumLeap (black), with comparative synchrotron data (red)

Results and discussion

Quantitative analysis of the Zr K-edge EXAFS was performed by fitting theoretical EXAFS spectra to the experimental data in R-space to obtain structural parameters (see Table 1). Included were the coordination number N, the bond length R, and the perturbation factor σ^2. The scattering contributions from the shortest Zr-Zr bond of 3.21 Å are also included. The correlation between bond length and perturbation factors between synchrotron and QuantumLeap data is excellent. The error bars of all parameters are small, which emphasizes the reliability of the results.

Summary

We have demonstrated that la-

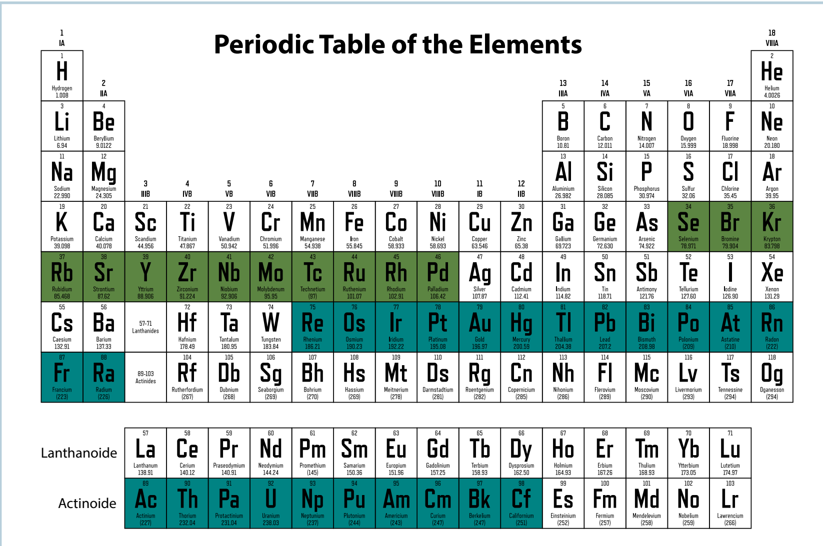


Fig. 1: Periodic table of the elements with highlighting of the elements with L- and K-edges between 12 and 25 keV. K-edges are shown in green, L-edges in turquoise

Strukturparameter	Synchrotron	Sigray QuantumLeap
N	12	12
R (Å)	3,23 ± 0,01	3,21 ± 0,01
σ^2 (Å^2)	0,009 ± 0,001	0,012 ± 0,002

Synchrotron and Sigray QuantumLeap Zr spectra (17.8 to 18.7 keV) were analyzed with Artemis. The results show excellent agreement with each other, demonstrating the exceptional high-energy XAS capabilities of the QuantumLeap

» Seite 9

» boratory XAS using Sigray's QuantumLeap system can provide synchrotron-like results for high-energy XAS analysis. Using well-established software, measurements on a Zr foil were converted into quantitative results (bond length, coordination number, and local atomistic disorder).

[1] B. Ravel and M. Newville, ATHENA, ARTEMIS, HEPHAESTUS: data analysis for X-ray absorption spectroscopy using IFEFFIT, Journal of Synchrotron Radiation 12, 537-541 (2005).

Please contact us
imaging@qd-microscopy.com

Vibrations in OptiCool – A Closer Look

OptiCool is an optical cryostat by Quantum Design, with superconducting magnets and closed helium circuit. The superconducting magnet requires a large cold head which, as a result of its design, emits significant vibrations. Thanks to a novel vibration isolation, the sample chamber is almost completely mechanically decoupled from the cold head. There are different ways to obtain a low vibration amplitude, as this article will show, using the X130 positioning system as an example. The amplitude alone is not sufficient to predict the performance of certain test setups.

At the sample holder, called sample pod, the amplitude is just 10 nm peak-to-peak at 1.7 K base temperature. For most applications, a piezo positioning system is required for the sample pod. These positioners have a low resonant frequency and consequently vibrate strongly when excited.

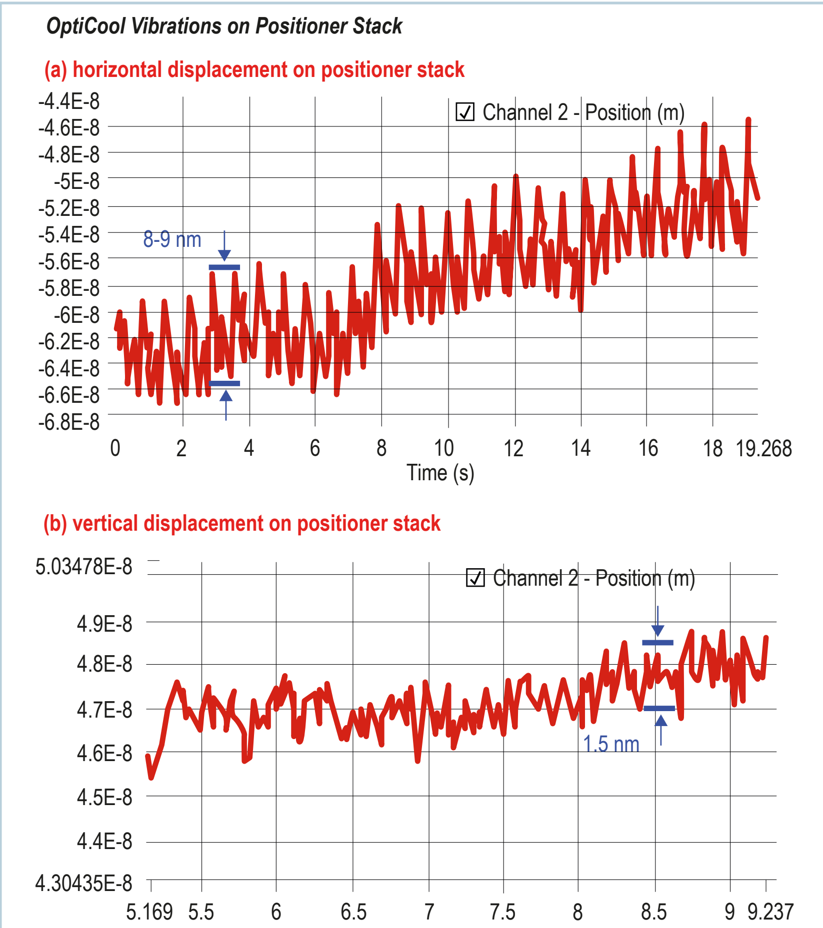


Fig. 1

The X130 positioning system consists of two ANPx311/RES/LT/HV piezos (X and Y) and an ANPz102/RES/LT/HV (Z) by Attocube. For measuring, a SmarAct PicoScale laser interferometer, set to a bandwidth of 153 Hz, was used.

OptiCool

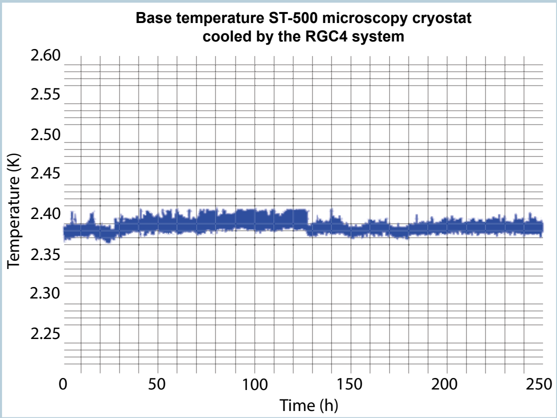
Figure 1 shows the time-dependent amplitude in (a) horizontal and (b) vertical directions. The peak-to-peak amplitude is just 8-9 nm horizontally and 1.5 nm vertically. These are the same values as those that are measured directly on the surface of the sample pod. This shows that, despite the positioning system, the vibrations are not stronger. This is due to the low forces acting on the sample pod. A low amplitude can be achieved either by minimizing the acting forces and/or by a design with high stiffness, which means high resonant frequency. The fact that the low stiffness of the piezos does not negatively affect performance shows clearly that hardly any kinetic energy is transferred from the cold head to the sample pod. It is thus not necessary to use a design with high stiffness. Accordingly, this also applies to all hardware that is installed on the sample pod in connection with the experiment (e.g. sample holder or positioning system).

Please contact us
cryo@qd-europe.com

Recirculating cryocooler for "wet" cryostats

The recirculating cryocooler from Janis release "wet" cryostats from their dependency on liquid helium. Janis RGC4 series combines the advantages of cryo systems with open and closed cooling cycles.

Instead of cooling the samples directly through the cold head of the cryocooler, a secondary cooling cycle is set up and the cold head of a classic "wet" cryostat is cooled. This has several advantages:



- Same flexibility and convenience as a continuous-flow cryostat without liquid helium
- Quick sample change without warming up the RGC4 cooler
- Outstanding thermal performance
- Low vibration

Pulse tube and GM coolers are available with 1 to 2W at 4.2 K. The system also includes a gas handling system and dry scroll pump for gas circulation.

Compatible cryostats are:

- optical ST-100
- non-optical ST-200
- compact ST-300 for use in a magnet

- UHV configuration ST-400 and
- microscopy configuration ST-500 and the ST-500 based probe station

Please contact us to discuss whether your cryostat from Janis or a third party provider is compatible with the recirculating cryocooler.

Please contact us
cryo@qd-europe.com

Autonomous vehicles – Optical filters for LiDAR applications

LiDAR is a sensing method that detects objects and maps their distances by sending an optical pulse at 905 nm or 1550 nm to the target and measuring the reflected return signal. Since conventional LiDAR system architectures use dedicated transmit and receive apertures, the resulting package has a relatively large footprint. However, leveraging polarization techniques can miniaturize the size of the optical subsystem. In addition, LiDAR systems routinely utilize narrow-band pass filters in both the transmitted and receiving path to improve the system signal-to-noise ratio.

Andover Corporation's self-reliant manufacturing approach places us in the optimal position to quickly provide customized prototypes of polarizing beamsplitters with unique angular performance characteristics to meet your LiDAR needs. With our 15 coating chambers, we can offer coating solutions from the UV range down to 15 µm. We also provide in-house manufacturing for coating fixtures, customized mounts, cutting, coring, shaping and polishing for a vast array of substrate materials.

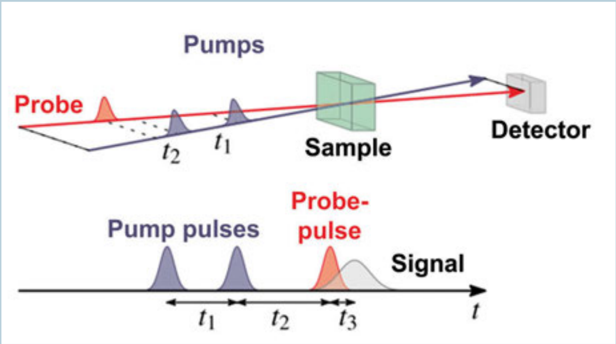
We provide standard bandpass filters that work with the common laser wavelengths used with most LiDAR systems, including 532 nm, 905 nm, 1064 nm, and 1550 nm.

This enables Andover Corporation to support both the development of new products and the production of optical sensors for the automotive industry. We offer customized engineering to provide superior and cost-effective solutions. Our extensive experience with image-quality bandpass filters, broadband AR coatings and polarizing beam splitters makes us an ideal partner for supplying the automotive industry with optical sensors. Our vertically integrated factory with in-house coating, manufacturing, optical assembly and testing capabilities can provide customized solutions at shorter lead-times.

Please contact us
optics@qd-europe.com

Spectroscopy with Fast Repetition Rates

Photosynthesis in plants is the subject of intensive research. The absorption of light and its conversion into energy takes place in accordance with molecular mechanisms in pigments or the so-called light-collecting complexes. Understanding them is not only a benefit with regard to our knowledge in the field of biology, but also helps us with a view to developing efficient methods of energy production from sunlight. A distinction is made between electronic excitation processes in single molecules and collective excitations in aggregated molecules. In the close surroundings of the pigments, new electronic energy states are generated, with allowed and non-allowed transitions. They are coupled to intra- and intermolecular vibrations. These are the cause of the extremely fast processes on the femtosecond scale that can be observed. To investigate these processes, methods have been developed that enable changes to be detected in the optical spectrum of the molecules. In parallel, ever shorter laser pulses have become possible, which allows such phenomena to be studied more closely. As the time scales of molecular processes are so short, the Heisenberg Uncertainty Principle cannot be ignored, according to which time and energy cannot be determined simultaneously with any desired resolution. 2D spectroscopy is the result of an evolution of pump-probe spectroscopy, in which information about the occupation and transition rates of electronic energy levels is obtained at different times. In this context, "two-dimensional" means plotting the signal as a function of the frequencies of excitation and emission. There are several methods based on this technology, which are well described in the publication which is the basis of this article (1). A common feature of some of these methods is that they require spectra to be recorded at high repetition rates. Depending on the method of choice, the spectral information may be hidden as a minimal variation on a high background. Making these weak signals visible requires a detector with a high dynamic range, the ratio of pixel capacitance to readout noise. CCD detectors often reach their limits here, since the readout noise (in the denominator) increases with increasing speed. Increasingly, sCMOS cameras can be used as an alternative. They combine high readout rates with very low readout noise. Meanwhile, CMOS sensors with large pixel sizes are available, in which dynamics, noise and sensitivity are combined in an ideal manner. Let us present you two cameras of this type that have proven useful for 2D or pump-probe spectroscopy. The ZYLA-5.5 sCMOS (Andor Technology) is capable of recording narrow, 8-lines spectra at up to 27000 Hz with 15 bit intensity resolution. The Marana sCMOS cameras (Andor Technology) with their higher quantum efficiency enable rates of up to 11655 Hz with comparable line counts and external triggering. In the multitrack mode, it is possible to capture spatially separated spectra almost simultaneously in rapid succession. The fastest possible recording rate depends on the number of lines and their spacing on the sensor. Thus, several thousand Hz are possible even for two tracks. As the binning of CMOS pixels would exceed the 16 bit scale of 65536 AD counts, FPGA preprocessing has been implemented, which transfers the added-up intensity values in 32 bit format to the computer.



Principle of 2D spectroscopy. From (1)

Andor Marana sCMOS Camera

With these features, Andor sCMOS cameras in conjunction with spectographs of the Kymera and Shamrock series provide for a versatility far beyond that of similar cameras by other manufacturers. If you are interested in more information, please feel free to ask us or discuss your application with one of our product managers from the Spectroscopy & Imaging department.

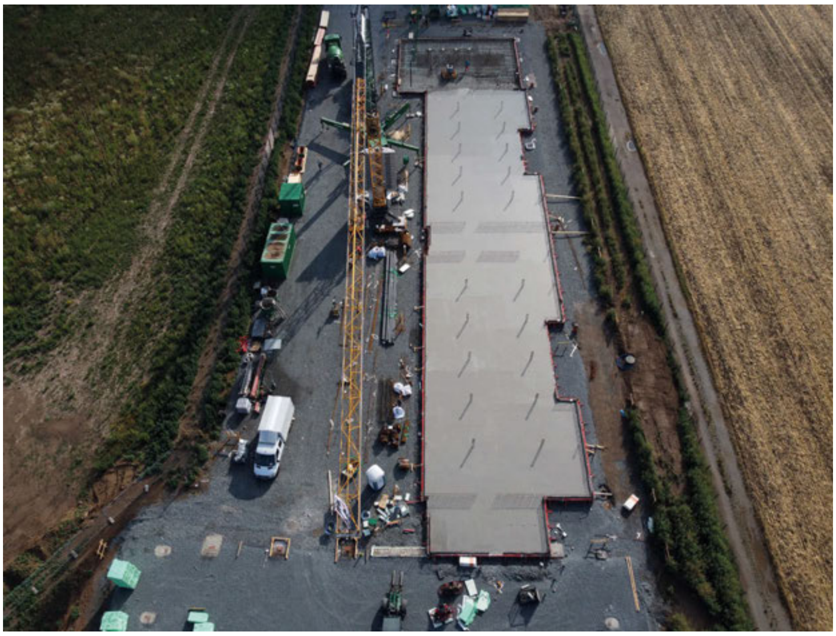
(1) A. Gelzinis, Ramūnas Augulis, Vytautas Butkus, Bruno Robert, Leonas Valkunas; BBA - Bioenergetics 1860 (2019) 271—285

Please contact us
spectroscopy@qd-europe.com

Headquarters Pfungstadt: Progress is being made

For a long time it felt like nothing was happening on our construction site for the new headquarters in Pfungstadt. There were even rumors of an alleged construction stop. But sometimes it's the bureaucracy that gets in the way. After about seven months of waiting, work on the office building could finally begin. The necessary ground work had already been completed for some time.

Now things are finally moving forward and our new office space is taking shape in the form of the floor slab. At 3 o'clock in the morning the work started. Eight trucks shuttled the concrete from Gernsheim to the construction site. A total of approximately 65 tons of steel for the reinforcement and 260 m³ of concrete were used. The dimensions of the future office complex are now already clearly visible. The warehouse will later join the office building in the southwest.

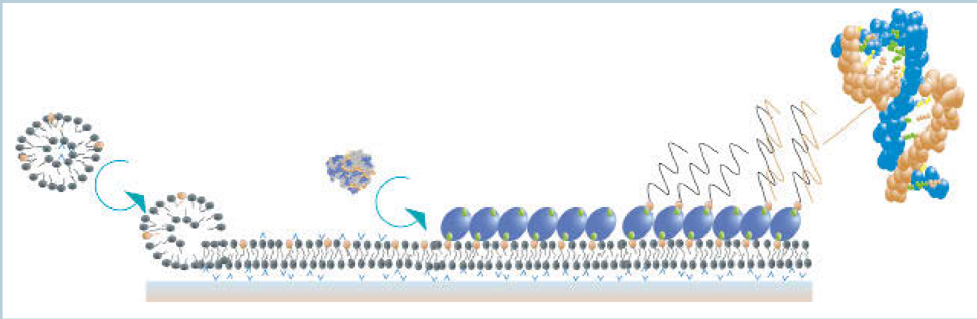


We are pleased with the great progress on our construction site and can hardly wait to move into the new headquarters in 2023.

Please contact us
spectrum@qd-europe.com

Factors Influencing the Stability of the QCM-D Baseline

Baseline stability is very important for obtaining high-quality and reproducible QCM-D data and measuring them with high-sensitivity. Here are some factors that will help you optimize baseline stability in your QCM-D measurements.

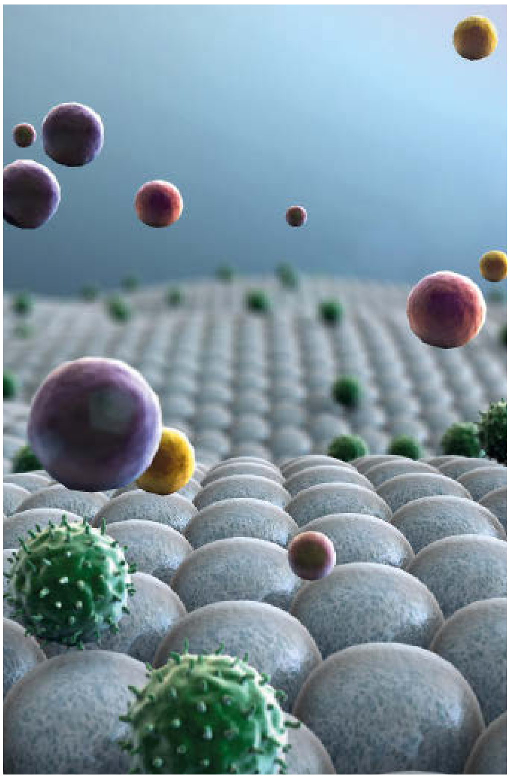


Bubble formation during measurement

Gas bubbles may form on the surface of the sensor when using a liquid that has not been properly degassed. Such bubbles will have an influence both on frequency and on dissipation.

E.g., gas solubility in water decreases with rising temperature. When working at a sensor temperature above room temperature and water-based buffer is introduced into the measuring chamber, then there is a risk of bubble formation. Note that the risk of bubble formation generally increases as the salt concentration of an aqueous solution decreases.

Solution: Use degassed liquids only or make sure that the gas solubility of the liquid is not reduced during measurement.



Temperature variations

a) Measurement with oscillating quartz crystal microbalances is very sensitive to temperature variations. The QSense measuring chambers have a very good temperature stabilization, but large temperature variations in the environment or in the sample solution may not be fully compensated. A change in temperature will change viscosity and density of a liquid and thus, f and D will change, too.

Solution: Make sure the temperature controller is switched on. Ensure a constant temperature in the environment of the instrument and provide for sufficient and constant air circulation. Protect the instrument against direct sunlight or air currents (e.g. from an air conditioner).

b) Unwanted resonant modes can interfere with the main resonance. These modes are usually very temperature dependent.

Solution: Change the set temperature slightly to get away from the mode interference.

After a system switch-on, insertion of modules or a change of the temperature setting, it will take some time before the entire chamber and the modules reach a temperature equilibrium - please bear that in mind. If possible, wait at least 30 minutes (but anyway until the signal is steady) before starting a measurement after such an event.

Reactions on the sensor back

The back side of the sensor is just as sensitive to surface reactions as the front side. Both surfaces influence the QCM-D signal in the same way. For example, a variation in the (relative) humidity on the back of the sensor (e.g., due to a leakage or a large temperature shift) can potentially change the amount of water adsorbed on the back and thus affect f and D. Note that the air space on the back of the sensor is in contact and exchange with the ambient environment through the holes for the spring-loaded contacts.

Make sure the dew point of the air around the platform (which is in contact with the back of the sensor) is significantly higher than the measuring temperature.

For additional tips and guidance, refer to Biolin Scientific's guide "How to optimize the QCM-D baseline stability" at www.biolinscientific.com

Please contact us
nano@qd-europe.com

MicroWriter – Our Direct-Writing Lithography System with Clever Features

High resolution and fast writing - these are the typical requirements for a direct-writing photolithography system. However, high resolution compromises writing speed and vice versa. For this reason, the developers of our MicroWriter systems have put much thought into the question of how these two requirements can be reconciled as far as possible. Even the first generation of the MicroWriter allowed the user to select different resolutions for different objects. The highest resolution is selected only for those objects for which high resolution is really important, whereas a lower resolution is chosen for objects for which high resolution is not an absolute must, which comes with the benefit of a higher writing speed.

This basic principle is now extended by various options for the writing quality - irrespective of the resolution used. The feature "Automatic Pixel Smoothing" gives users the option to decide about the quality of the edges of the structures to be written.

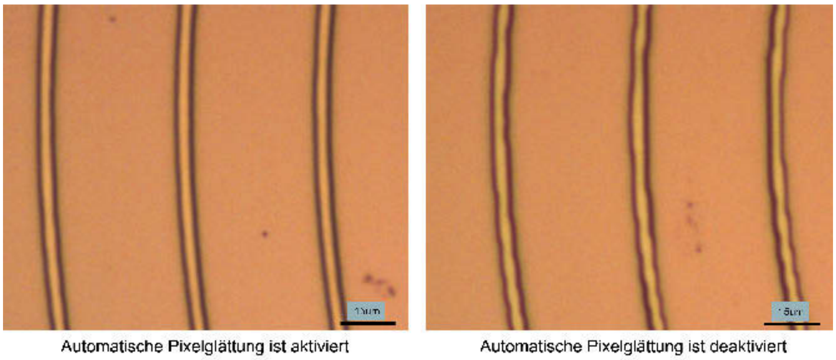


Fig. 1

The example in figure 1 shows the difference. The gap width of the coil is 2.5 µm and the resolution of writing was 1 µm. The roughness of the edges can typically be observed in the outstanding range of 30 nm. If this feature is not used, the writing speed increases dramatically, however, at the expense of edge quality.

The second important feature is the so-called "Virtual Mask Aligner", which offers the possibility of placing the object to be written over the optical image of the sample surface. This is very helpful if structures to be written are to be aligned with structures that are already on the surface. A typical example are contact pads for e.g. graphene or 2D materials. Figure 2 shows how this looks in the software, while figure 3 is an actual result from one of our customers (courtesy of UGC-DAE Consortium for Scientific Research, Indore, India).

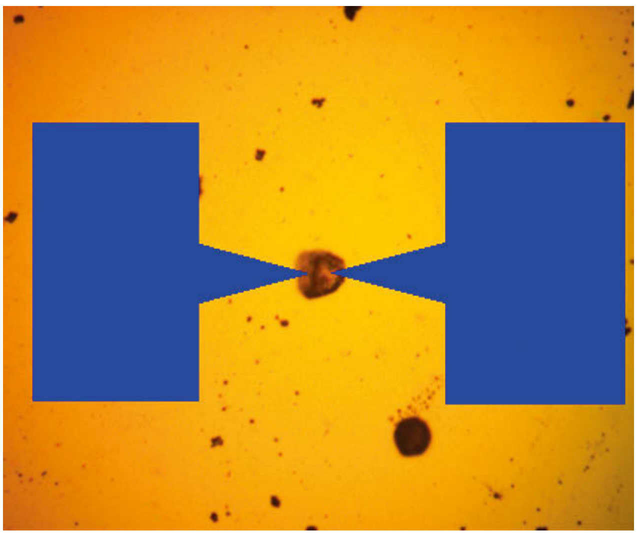


Fig. 2

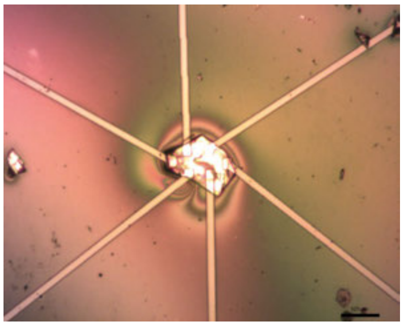


Fig. 3

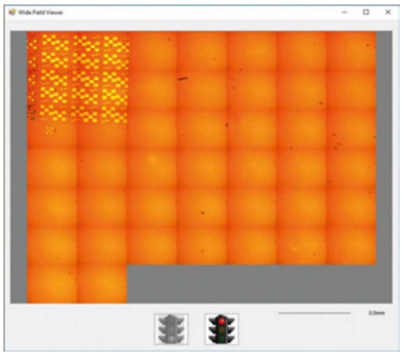


Fig. 4

The last feature is the "Wide Field Viewer". This feature allows you to quickly and easily generate a larger overview image of the sample surface. The system automatically circles the starting point, capturing one optical image at a time. Each further image will be stitched together to create an ever larger overview image. This feature can be used, e.g., to find alignment markers or to look at already written structures for a first inspection.

Please contact us
materials@qd-europe.com

The Lock-In Amplifier – NOT a Closed Book

M81

The lock-in amplifier was developed in 1941, and has ever since undisputedly occupied a very important place when it comes to sensitive electrical measurements. But "lock-ins" are also used in other areas: E.g., in a VSM magnetometer for sensitive magnetic measurements such an amplifier is an essential part of the measuring electronics.

A lock-in amplifier "equalizes" frequencies, so, as far as electrical measurements are concerned, we always refer to AC applications. AC means "alternating current", and an example of what can be measured is AC resistance. In its most simple form, the lock-in is an AC voltmeter that measures at a fixed frequency only. The signal from the AC current source is supplied to the lock-in, passing

through the sample, but it is also supplied directly as a reference signal (of course, it would also be possible to generate the reference signal internally).

Advantages of the lock-in technology: The amplitude can be low, and background noise and other interfering signals or frequencies can be removed, since, in a simplification, we are only looking at this one frequency. In the figure, the basic structure of a lock-in system is shown. The components highlighted in gray form part of the DSP (digital signal processor). The DSP is the heart of any modern lock-in instrument.

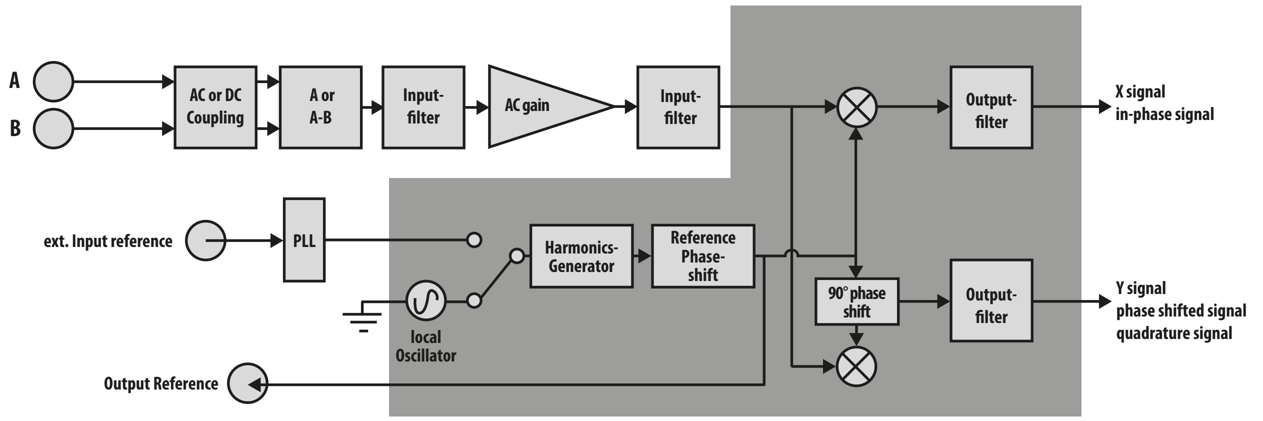
From the figure, it also becomes clear that in order to really understand the technology, one has to have a closer look e.g. at the function and mode of action of the various filters. But for those of our readers who simply want to make sensitive electrical measurements, listen: Lake Shore's M81 measuring system features an integrated lock-in amplifier that can easily be activated and deactivated!

Learn more about the lock-in technology and gain background knowledge, including about filters, noise and different types of noise, as well as precision and accuracy, by reading Lake Shore Cryptotronics' white paper "The Lock-In Amplifier Explained and Reimagined", which we will be happy to send you on request free of charge, either by e-mail or as a printout.

For more information, please visit our website.

www.qd-europe.com

Please contact us
materials@qd-europe.com



New Enhanced Scratch Test Module for the NanoTest Vantage Platform 5

MicroMaterials has revised and significantly enhanced the scratch and wear option of the NanoTest Vantage Indenter for Platform 5.

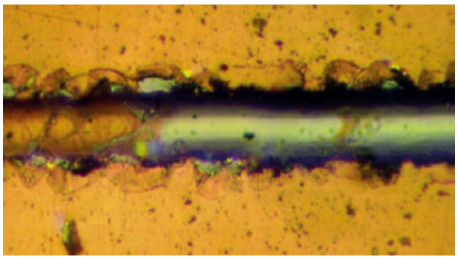
The enhancements provide the ability to take advantage of the NanoTest's high lateral stiffness and thermal stability. The user has full control over loading, unloading and holding segments to perform scratch and wear tests with complex loading procedures. This opens up new types of experiments, such as abrasion simulations or pendulum wear tests.

To perform wear tests directly, multiple parallel scratches can be generated in a single experiment run. In doing so, the software generates a random offset for the start position of each scratch.

For detailed investigation of wear and fracture processes, analysis regions can be defined and the software then automatically calculates the mean and standard deviation for all measured parameters for each scan. Measured parameters include load and residual depth, friction force and coefficients, and six different surface roughnesses.

The innovations in Platform 5 at a glance:

- User-defined multi-load loading option for single scratch and repeated scratch tests.



- Abrasion simulation
- Pendulum wear tests
- User-defined data density
- Data analysis and reporting:
- Multi-axis composite charts
- Improved compensation options
- Integrated microscopy and positioning
- Automatic analysis of surface roughness statistics. Depth, friction and ECR for user-defined regions
- Calculation of step height
- Test reports according to ISO/CEN 17627

More details and a case study can be found at: bit.ly/3zSNmuM

Please do not hesitate to contact us if you have any questions regarding this or other modules in conjunction with NanoTest Vantage.

Please contact us
materials@qd-europe.com

Follow us on LinkedIn:
https://www.linkedin.com/company/quantum-design-europe

European Headquarters
Quantum Design GmbH
Im Tiefen See 58, 64293 Darmstadt, Germany
Phone +49 6151 8806-0, Fax +49 6151 8806 920
E-mail spectrum@qd-europe.com
www.qd-europe.com

Quantum Design **BeNeLux**
Meerstraat 177
B-1850 Grimbergen, Belgium
Phone +32 2 3084324
Mobile +32 495797175
E-mail struyve@qd-europe.com

Quantum Design **Czech Rep.** and **Slovak. Rep.**
Krivoklatska 37, 199 00 Praha 9, Czech. Rep.
Phone +420 607 014 278, Fax +420 24 1046850
E-mail czechia@qd-europe.com

Quantum Design **France** SARL
Bâtiment Mac Kinley, 1, avenue de l'Atlantique,
91940 Les Ulis, France
Phone +33 1 69194949, Fax +33 1 69194930
E-mail france@qd-europe.com

Quantum Design Iberia
(for **Portugal** and **Spain**)
Roca i Roca, 45, 08226 Terrassa (Barcelona), Spain
Phone and Fax +34 937349168
E-mail boira@qd-europe.com

Quantum Design s.r.l., **Italia**
Via Francesco Sapori, 27
00143 Roma, Italy
Phone +39 06 5004204, Fax +39 06 5010389
E-mail italy@qd-europe.com

Quantum Design **Magyarország**
Primet Méréstechnikai Kft
Eszak u. 24, HU-1038 Budapest
Phone and Fax +36 1 2402711,
E-mail steinbach@qd-europe.com

Quantum Design Nordic
(for **Denmark, Finland, Norway** and **Sweden**)
Roddarestigen 3, 182 35 Danderyd, Sweden
Phone +46 8 41071791
E-mail eriksson@qd-europe.com

Quantum Design Przedstawicielstwo **Polska**
Mikołów: tel.:+48 32 24457
Fax: +48 32 4281169, kom.: +48 50 255112014
pdluzewski@qd-europe.com lub
Chorzów: tel.: +48 32 2482048
Fax: +48 32 70 21 160, kom.: +48 51 5166893
E-mail kowalczyk@qd-europe.com

Quantum Design SRL
(for **Romania** and **Bulgaria**)
Str Ion Nistor Nr 4, et 1, M2E
030041 Bucharest, Ro.
Phone +40 75 50 39 900, Fax +40 31 7107156
E-mail buiu@qd-europe.com

Quantum Design AG **Suisse**
Route du Roule 41, 1723 Marly, Switzerland
Phone +41 21 8699033, Fax +41 21 8699308
E-mail reinicke@qd-europe.com

Quantum Design **Turkey**
Phone: +90 544 741 99 97
E-mail turkiye@qd-europe.com

Quantum Design Ltd. **UK** and **Ireland**
1 Mole Business Park, KT22 7BA Leatherhead,
Surrey, United Kingdom
Phone +44 13 72378822, Fax +44 13 72375353
E-mail info@qd-uki.co.uk

Quantum Design **Russia**
(for Russia and Central Eurasia)
Phone +7 495 938-1866 , Fax +7 495 938-1907
E-mail academ@qd-europe.com

Editor: Joachim Weiss, PhD
Please note that not all products are available in every country.

carbon neutral
natureOffice.com | DE-617-226SY2T
print production