SPECTRUM

News from Quantum Design Europe

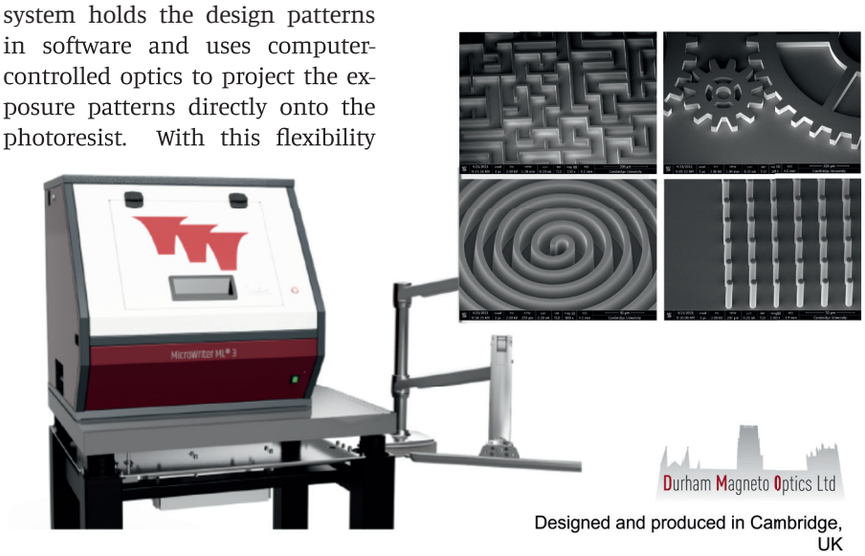
Edition 41 | January 2024

MicroWriter ML 3 - The future of photolithography

Conventional photolithography is a process that uses a mask aligner to transfer patterns from a chromium-glass mask onto a substrate coated with a photoresist layer. This process has several limitations, including:

- Overlay accuracy is limited by the fixed pattern on the mask.
- Alignment with randomly distributed samples (often needed for research of 2D materials) is difficult because the pattern positions on the mask cannot be changed.
- Backside alignment is complex.
- Flexible or non-flat substrates are difficult to work with.

The MicroWriter ML 3 systems offer a solution to these obstacles. The system holds the design patterns in software and uses computer-controlled optics to project the exposure patterns directly onto the photoresist. With this flexibility plus a simple and intuitive Windows user interface, the overlay procedure (with an overlay accuracy down to +/- 0.5 µm) can be easily achieved (Fig. 1).



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alpha 2.0 – Advanced ellipsometer for routine measurements

The new and advanced alpha 2.0 spectroscopic ellipsometer is the suitor of the well-renowned alpha-SE. It is a budget-friendly option for routine measurements of thin film thickness and refractive index. Its compact footprint and simple setup make alpha 2.0 easy to handle while it provides the full advantages of spectroscopic ellipsometry. It was designed for ease of use: Simply place the sample on the stage, choose the model that matches your film, click "measure", and you get results within seconds.

The technology with two rotating elements — rotating compensator and rotating

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Quantum Design EUROPE

MicroWriter ML 3 – The future of photolithography

» Alignment with randomly distributed samples can be performed using the software tool "Virtual Mask Aligner" (Fig. 2). Users can locate their samples and then digitally superimpose the design pattern with their sample in real time before the exposure. For the backside alignment, the MicroWriter ML 3 can be equipped with a backside alignment camera, which can feed in a real-time microscope image. (Fig. 3) It can also be used to expose a variety of different substrates, including diamond or liquid polymer. (Fig. 4)

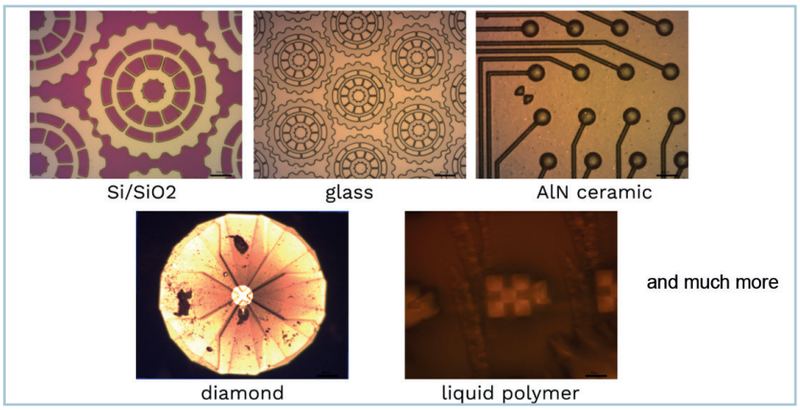

Fig. 4: Exposure results of various substrates with the MicroWriter ML 3.

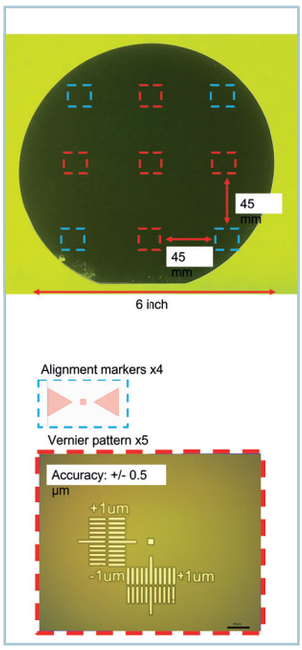

Fig. 1: Vernier pattern and alignment marks on a 6 inch wafer, created with the MicroWriter ML 3, show that the overlay accuracy can be as good as +/- 0.5 µm.

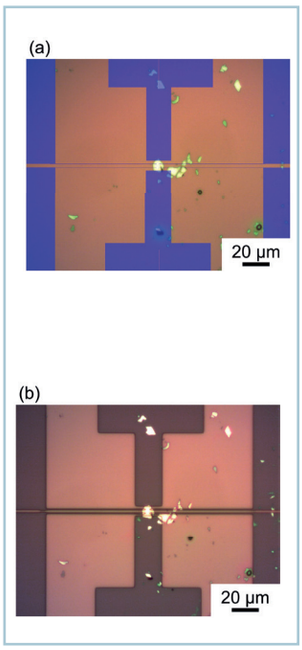

Fig. 2: Exposure with 'Virtual Mask Aligner" software: (a) A designed pattern, put on a sample before exposure, and (b) the exposed and developed sample.

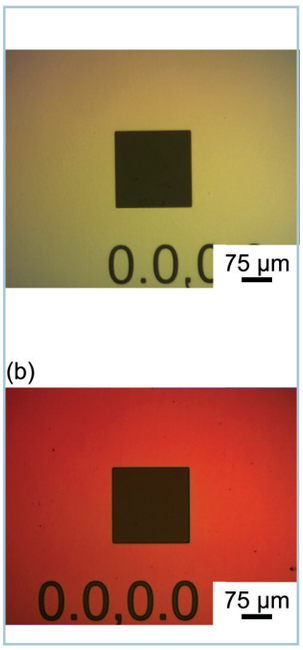

Fig. 3: Real time microscope image of (a) a camera on the top and (b) a camera on the backside of the MicroWriter ML 3.

The MicroWriter ML 3 is a compact, powerful, and affordable direct-write optical lithography device that offers unprecedented value for money. It has a low cost of ownership, with long-life, solid-state light sources and low maintenance requirements. It also has an excellent environmental footprint: Power consumption of the device is comparable to that of a laptop.

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alpha 2.0 – Advanced ellipsometer for routine measurements

» analyzer — guarantees high-precision measurements including Mueller matrix.

By CCD detection, the entire spectral range from 400-1000 nm is measured with 190 wavelengths simultaneously within 5-10 seconds. The system features 3 different angles of incidence: 65°, 70° and 75° (manually adjustable) and uses sensors that prevent incorrect angle settings. It also enables transmission measurements (ellipsometry and intensity).

With a small footprint of < 50 cm x 35 cm, the alpha 2.0 will find space in the smallest of labs. The instrument operates on powerful CompleteEASE software which is also used in its predecessor alpha-SE and other, larger systems such as M-2000 and RC2. We regularly provide data analysis trainings with CompleteEASE.

Contact us for more information!

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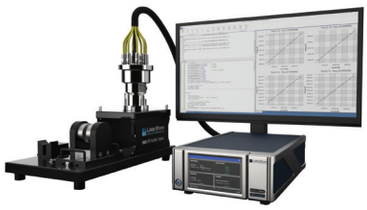
Measuring Hall effect made simple

Our partner Lake Shore offers a great variety of systems for measuring the Hall effect. Model HMS-TT is a compact entry-level system with a broad range of features. It is specified for sample resistances up to 1 gigaohm and allows even higher resistances.

HMS-TT is a complete hard and software package. It contains: Measurement platform with 1 T permanent magnet, M91 FastHall Measurement Controller, computer with MeasureLink software, a set of sample holders and all necessary cabling (incl. triaxial cable for low-noise sample connection). Measurements and evaluation are fully automated. The contacts can be checked for ohmic behavior and the software optimizes the measurement settings. The system provides measurement data and further sample parameters like Hall coefficient, mobility and charge carrier concentration.



The HMS-TT measurement system only requires an 80 x 80 cm^2 tabletop space and a socket. Optionally, the system can be equipped with gate bias and single point temperature options for measurements at ~77 K. Measuring in Fast Hall mode is always quicker than standard Hall measurements, because it does not require magnetic field reversal. Thanks to its broad measurement range, the HMS TT system is suited for a variety of sample materials like solar cells, organic electronics, indium tin oxides (ITO), various semiconductors (III-V, II.VI, elemental, TMDC,...) topological and 2D materials, etc.

We have a system in our demo lab and will be glad to present all features to you at our premises or through an online demonstration.

Samples	10 mm x 10 mm, Van der Pauw or Hall-Bar
Resistance range	10 mΩ to 1 GΩ
Mobility	0,01 to 10^6 cm^2/V s
Carrier concentration	800 to 8 x 10^{23} cm^{-3}

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Measuring thick film stresses

One of the most common systems to measure stress in thin films is using the Flexus from Toho. In most cases, film thickness doesn't exceed 1/100 of the substrate thickness. Sometimes, it seems to be desirable to measure the stress in much thicker films. Calculations for the stress measurements of thin films can be modified for applications with thicker films. To do this, correction factors are used which are based on the film/substrate thickness ratio.

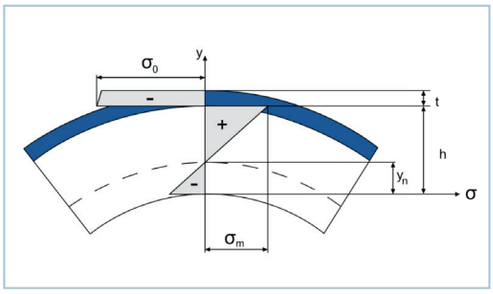
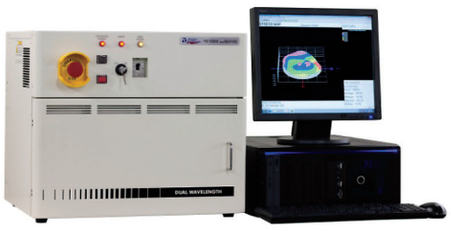


Fig. 1: Stress distribution

One example of a thick film stress measurement is the stress in a silicon die attached to a package or a lead frame. The "film" is the silicon die itself and the "substrate" is the package or the lead frame. The film/substrate ratio in this case can be as high as 1/2. The stress distribution in the thick film and the substrate is schematically shown in Fig. 1. A film in compression is shown on a substrate ($\sigma < 0$) with an average compression in the film of σ_0. The stress in the substrate ranges from a maximum tension of σm



adjacent to the film, to a maximum compression on the backside.

To learn more about this application, you can download the full appliccation note from download area on our website.

https://qd-europe.com/flx-flexus/

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MPMS and PPMS: Pioneers in the research of room-temperature superconductivity

The search for a room-temperature superconductor is still one of the most exciting endeavors in experimental condensed matter physics. In the past years, published reports on the discovery of this long sought-after material have attracted a lot of attention. There were many controversies in the research community about these discoveries, and many of them were evaluated and refuted. A material that shows superconductive properties at room temperature would allow electric currents to flow without the power losses that occur even in the best conventional metal conductors existing today.

The MPMS (Magnetic Property Measurement System) and PPMS (Physical Property Measurement System) from Quantum Design are the leading platforms for cryogenic material characterization that are used in the search for new superconducting materials. Almost every research institute and laboratory that is involved in the search uses one, both or several of these instruments when conducting experiments in the characterization of new materials.

The magnetic AC susceptibility is a great test of the superconductivity in all materials, including materials under high pressure. The jump to superconductivity leads to a major drop in the AC susceptibility. Using the most sensitive technology for the measurement of susceptibility based on a SQUID sensor, makes the MPMS 3 the world-leading AC-susceptometer. A long-time expert in the field is Prof. Cava from the department of chemistry at the Princeton University. The group states they discover one to two superconductors per year on average. The Cava research group works with both the MPMS and PPMS. With the discovery of superconductivity at temperatures to about 22 K in the year 1988, Cava and his group achieved a transition temperature of 29.8 K in a Ba0.6K0.4BiO3 single crystal. Using the superconducting transition temperature for this material was determined by Cava et al. on the basis of a magnetization measurement of the magnetic shielding (aka Meissner effect) while cooling the sample in a magnetic field of 190 Oe in the MPMS. Together with the first discovery of high-temperature superconductivity by J.G. Bednorz and Prof. Mueller at IBM (Zurich) in the La-Ba-Cu-O materials, the results from Prof. Cava helped break through the psychological barrier that had kept physicists from looking for superconductivity at room temperature. Currently, cuprates under normal atmospheric pressure hold the record in transition temperature and show superconductivity to 138 K (-135 C). These were discovered by Prof. Schilling and his group at the ETH in Zurich and also characterized with an MPMS.

Fig. 2: World-famous SQUID expert Prof. John Clarke (UCB) presents the MPMS 3 in his talk about applications with SQUID devices during the APS conference.

The PPMS provides a range of measurement options which can help clarify underlying mechanisms that are responsible for exotic material states including superconductivity. This includes measurements of the specific heat, thermal conductivity and dilation, to name just a few. One common measurement of the superconducting state is the characterization of the full loss of electrical resistance below a specific temperature. Fig. 3 shows sample data drawn from a PPMS resistance measurement.

The resistance measurements conducted in the PPMS have soon become the standard testing method for the validation of claims on the discovery of new superconductors, especially at room temperature. Data analysis, especially the so-called "background subtraction", must be carried out very carefully since the relevant signal is often very small compared with the noise. This and other intricacies can lead to misleading interpretations of test results.

Fig. 4 shows a workbench in the physics lab of Prof. Gan Cao at the University of Colorado Boulder, where a sample of LK-99 is mounted on a PPMS puck for a test. LK-998 is the latest material said to be superconductive at room temperature. The Washington Post tells the story of the LK-99 discovery, which began with the announcement of

Fig. 1: A magnet flows over a cold superconductor and shows the Meissner effect.

Korean researchers that went viral on social media. The alleged discovery led to a temporary rally of Korean superconductor stocks (see fig. 5), while they were met with great skepticism among the research community.

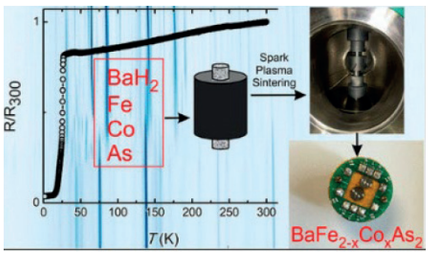

Fig. 3: Electrical measurement of a superconductive transition in the PPMS.

As often with similar discoveries, both the PPMS and MPMS played a role during the first research steps, when the discovery of the superconductive state in LK-99 was claimed, and during the subsequent efforts of labs around the world to repeat the experiments and achieve the same results. No doubt that the way that experiments are carried out, data are analyzed and results are interpreted still has a high significance for the evaluation and acceptance of such a discovery, and in particular for a monumental discovery such as room-temperature superconductivity. The MPMS and PPMS platforms are fundamental tools for researchers that work in this field. It is unlikely that a new superconductive material and especially a room-temperature superconductor will be discovered, without its thorough characterization inside a Quantum Design MPMS or PPMS.


The Washington Post
Democracy Dies in Darkness

LK-99 is not a superconductor. "One more nail in the coffin," Phillips wrote in an email, forwarding yet another paper that adds to the pile of evidence. "So your headline is quite simple."

In Gang Cao's physics lab at the University of Colorado at Boulder, scientists can attach probes to samples of possible superconducting materials to test their electrical resistance. (Linda Jaquez for The Washington Post)

Fig. 4 Article in the Washington Post on LK-99 with the MPMS EverCool and the PPMS puck.

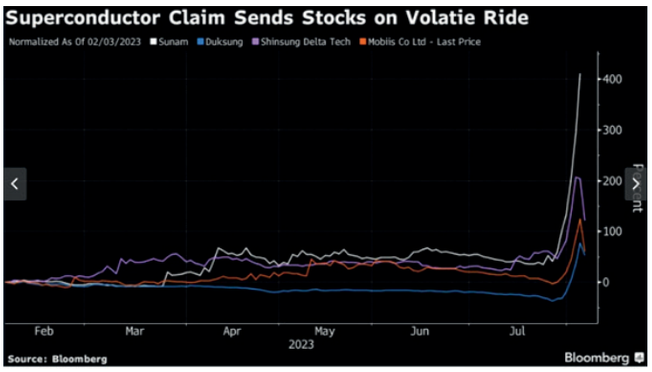

Fig. 5: Korean superconducting shares reach their peak after the discovery of LK-99

This is how these platforms contribute to the scientific process and to the understanding of phenomena like the room-temperature superconductivity:

Precision measurements:
MPMS and PPMS systems allow high-precision and high-sensitivity measurements of different physical properties like magnetic susceptibility, electrical resistance, specific heat and more. In connection with superconductivity research, they enable the precise measurement of the critical temperature (Tc), critical magnetic field (Hc) and other relevant parameters.

Characterization:
The systems facilitate the systematic evaluation of material properties under various conditions like different temperatures, magnetic fields and loads. This helps with the identification of the unique behavior and the material properties of materials, including their service transitions and critical parameters.

Understanding phase transitions:
Superconductive materials show phase transitions at certain temperatures and magnetic field strengths. With the MPMS and PPMS systems, researchers can track and analyze these transitions and thus evaluate the underlying mechanisms.

Versatility:
MPMS and PPMS systems are versatile instruments that can be used for a broad range of materials and phenomena aside from superconductivity. This versatility makes them very valuable for interdisciplinary research.

Real time monitoring:
Researchers can monitor material behavior at temperature or magnetic field changes in real time and gain insights into the dynamic processes at superconducting transitions.

Comparison and validation:
The availability of standardized measurement methods and devices like the MPMS and PPMS systems facilitates the comparison between different research groups and labs. This enhances the validation and reproducibility of test results.

Innovation:
Researchers can use the platforms to develop new materials with optimized properties for potential technological applications. By understanding the behavior of existing materials they can adapt compositions and structures to achieve the desired superconducting properties.

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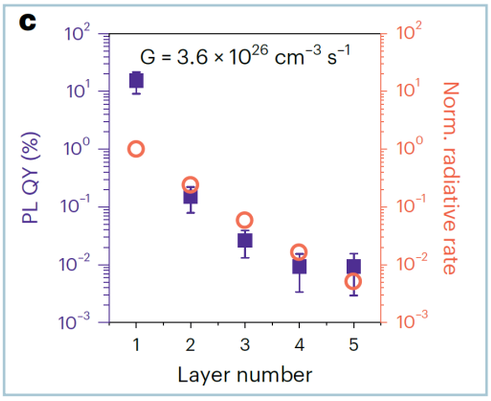
Black phosphorus – A surprise from the world of photon sources

Black phosphorus is a unique optoelectronic material with a strong, tunable emission of mid infrared to visible wavelengths. A better understanding of the physics of this system is of great interest because of its technical application fields.

Intriguing results were achieved by the group around Prof. Javey in Berkely, who analyzed the dependency of the photoluminescence quantum yield in black phosphorus [1]. When the thickness decreased to approx. 4 nm, they observed a decrease in photoluminescence due to enhanced surface carrier recombination. This had actually been expected. Unexpectedly, the intensity increased significantly as the thickness further decreased. The average quantum yield value for mono layers lay at about 30%. This behavior arises from the free-carrier to excitonic transition in black phosphorus thin films, and differs from the behavior of conventional semiconductors, where the photoluminescence quantum yield declines with decreasing thickness.

There was another surprising result: The carrier recombination speed on the surface of black phosphorus is two orders of magnitude lower than the lowest value reported in the literature for any semiconductor with or without passivation. This is interesting for photonic applications in general and photonic embedded circuits in particular. A material system of black phosphorus thus results in significantly higher quantum yields than conventional semiconductors.



Measured photoluminescence quantum yield at ~3,6 × 10^{26} cm^{-3} s^{-1} for various thicknesses, together with the calculated radiation, normalized for the monolayer.

The photoluminescence measurements were carried out with a Cryostation s200 from Montana Instruments. The closed-cycle cryostats from MI allow a very high numerical aperture at minimal vibration levels inside the sample chamber.

The full article is available here:

[1] Higashitarumizu, N., Uddin, S.Z., Weinberg, D. et al. Anomalous thickness dependence of photoluminescence quantum yield in black phosphorous. Nat. Nanotechnol. 18, 507—513 (2023). https://doi.org/10.1038/s41565-023-01335-0

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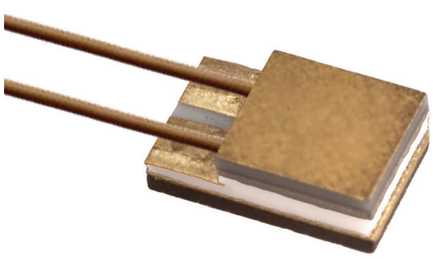
29-year long-term stability of Cernox temperature sensors

The consistent accuracy is of utmost importance for sensors used over long periods of time. This is why it is of great interest to know the sensor performance after a certain number of quick cooling processes, known as thermal shock. One way to determine this is the long-term stability, which gives the expected precision after a number of thermal cycles. Lake Shore indicates values from 305 K to 77 K after 200 thermal shocks.



But what happens, if the sensor is used after years of storage at room temperature? The link below gives the answer published by Lake Shore. The results are particularly interesting for extraterrestrial applications, since sensors are normally produced years before they start their journey into space.

For this study, the very first Cernox sensors, which were produced 29 years ago, were periodically analyzed and recalibrated. Based on these measurements, their long-term stability was determined. With ±10 mK for temperatures below 10 K, the sensors still show an excellent accuracy. Their long-term stability is in the range of the calibration with ±6 mK at 10 K. Check out the study for further details on the measurements and results.

For questions on Cernox sensors and low-temperature measurements, please contact us.

https://bit.ly/44bu1kH

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Basics of electrical measurements Part 1 – The correct usage of currenct and voltage

This article is the start of a small series on the basics of electrical measurements. In this part, we will discuss the use of current and voltage.

The resistance R of a sample (also called DUT Device under Test) is given by the relation of voltage U and current I:

R = U/I

This well-known linear relation is called ohmic resistance or ohmic behavior. Therefore, to calculate resistance, you need to know the current and the voltage.

In practice, this is achieved by either presetting the voltage by using a Voltage Source (VS) and then measuring the current, or by using a Current Source (CS) to preset a certain current and then measuring the voltage. At a first (brief) glance, both procedures look similar or even the same. When looking closer, you can see the difference.

The general rule is: Use a current source and measure the voltage with small resistances. With high resistances (from 10 megohm), it is better to use a voltage source and measure the current.

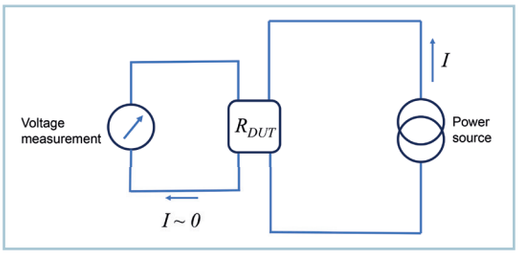
With high-resistance samples, the cabling capacity comes into play. In this case, "loading" with voltage is quicker than using a current source. The advantage here is the measurement time. Another reason is the thermal noise of the current (voltage source setup). The current noise decreases with higher resistance — according to formula [1]. The thermal noise of the voltage increases with the current source setup with increasing resistance — see formula [2].

$$I_{RMS} \sim \sqrt{\{1/R\}} \qquad [1]$$

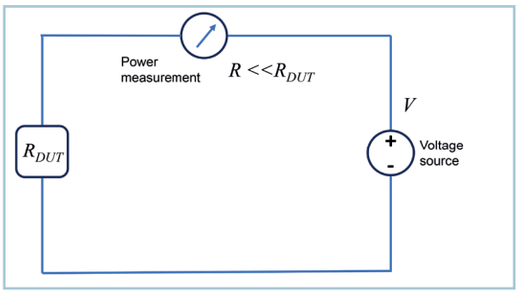
$$U_{RMS} \sim \sqrt{\{R\}} \qquad [2]$$

Low-resistance samples can be LEDs, diodes, metals, alloys and superconductors (R=0). With these, it is useful to control the current. You want to create a current-voltage characteristic and apply several excitation points. When using a voltage source, the current could unintentionally increase severely, causing unwanted heating.

Whatever your samples require - the M81-SSM from Lake Shore will help you manage. M81 is a system family suited for both current source — voltage measurement and voltage source — current measurement. This flexibility is a result of the M81's modular concept. Contact us to learn more about its many features.



4-point measurement with one current source



Measurement using a voltage source ("electrometer mode")

Current source – voltage measurement

- Small and medium resistances
- Controlled current
- Thereby control of heating
- Low noise in the measured voltage

Voltage source – current measurement

- High resistances (>10 megaohm)
- Low impact of cabling or sample capacity
- Low noise in measured current

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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.

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Woollam Newsletter #2023 out now

The new Woollam newsletter features a great number of interesting articles:

The Wave Front: Cutting-Edge Applications Using Spectroscopic Ellipsometry

The text briefly depicts important applications like Perowskite, lithography, optical coatings, lenses and displays and it illustrates which information can be extracted with ellipsometry.

New Instrument: alpha 2.0

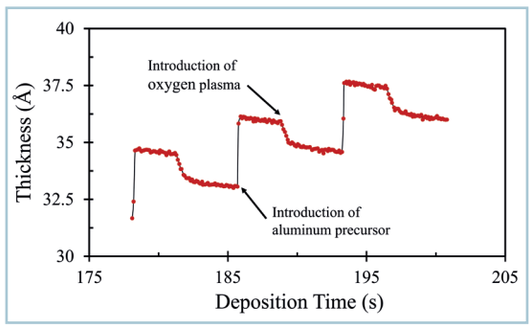
The new alpha 2.0 is presented. Read the article on page 1 of this issue.

In Situ Spectroscopic Ellipsometry: Applications to Atomic Layer Deposition

The article gives a short introduction to atomic layer deposition (ALD) and gives examples that show how our in situ ellipsometer provides information during the ALD growth process. The ellipsometer is flange mounted directly to the ALD system and monitors the layer growth in real time.

CompleteEASE: More Complete. More User-friendly.

Only few people remember what the acronym EASE in CompleteEASE stands for: It means "Complete Easy-to-use Acquisition/ Analysis Software for Spectroscopic Ellipsometry" — a play on words and tongue twister and at the same time the precise description of what this software platform really is. CompleteEASE provides the best methods to capture spectroscopic ellipsometry data and analyze it with the latest technologies to gain useful results. Woollam continuously improve the user-friendliness and keep enhancing the numerous measurement and analysis functions. The launch of CompleteEASE 6 in 2017 was an important upgrade in regards to functionality and ease-of-use. Based on this great fundament, many features have since been added to simplify features and enhance the scope of functions. This article illustrates some of the improvements that have been implemented last year. To use CompleteEASE, you need a license for every computer that you want to use it on. Each ellipsometer is automatically shipped with 5 licenses so it can be used on up to 5 different computers simultaneously. However, taking advantage of this possibility can lead to certain limitations. In case there are more than 5 users, and some of them only use it occasionally so that a full license seems out of range, Woollam have come up with a new licensing method. CompleEASE can now be licensed with so-called "floating" licenses that are installed on a network or server computer. This way everyone with access to this network can use



Plasma-enhanced (PE)-ALD of Al2O3 measured with 50msec time resolution (data courtesy of V. Vandalon & H. Knoops, Eindhoven University of Technology)

Spotlight Story: Tom Tiwald's Artistic Legacy Through the Lens of Infrared-SE

Our IR ellipsometry expert Dr. Tom Tiwald talks about how he ended up in ellipsometry and why he still finds it fascinating today.

Featured International Rep: Quantum Design Europe

The partnership between Quantum Design and J.A. Woollam began more than 30 years ago. Today Quantum Design sells Woollam ellipsometers across Europe with great success

You can also read about:

- Featured Researcher: Parag Banerjee
- Employee Spotlights
- J.A. Woollam Scholarship Recipients

The full newsletter can be downloaded from our ellipsometry website and directly from Woollam.

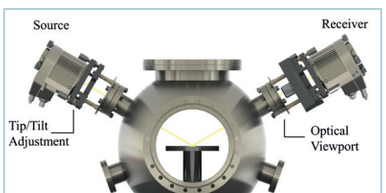
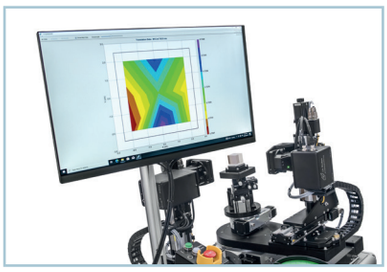


Fig.1: ALD chamber with attached in situ ellipsometer iSE



Ellypsometric measurement

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Our new company building – working on a new level

It's time — our new company building with sales, service, exhibition, warehouse, and administration has been occupied and operational since early November. After almost 50 years at our established location in Darmstadt, it was time to open a new chapter in the company's history. Evolving requirements and expectations for a modern workplace, coupled with the growth of our business, made a realignment inevitable. It quickly became apparent that there were three possible options. The most obvious was an extensive renovation and modernization at the existing location. In addition, another rental property could have been an option, and finally, a self-built new construction. After intensive discussions with our headquarters in San Diego, our banks, and considering a stable financial situation, we set our course towards ownership.

Already during the search for a suitable plot, it became clear that this process would not always be straightforward. Ultimately, we found a receptive partner in the town of Pfungstadt and purchased an 8.500m² plot in a small but fine industrial area yet to be developed.

This gave us the opportunity to design a building that is precisely tailored to our specific requirements. For the planning and execution of the construction project, we engaged the architectural firm Zimmermann from Bensheim, which accompanied us exceptionally competently throughout the entire process.

The office and administrative building spans three floors with a total of 2.800m² of office space. The ground floor is almost entirely occupied by our demonstration and service areas, complemented by our new training and assembly room. This room provides an ideal environment for training sessions, workshops, and other events. A special feature is the light- and sun-filled office floors, which not only provide enough space for efficient work but also a modern and open office structure. This approach is supported by a total of five kitchen areas and appealing lounge corners.

The warehouse is also tailored to our needs and includes more than 250 pallet spaces, a large small parts storage, and a generous outdoor storage area. On our property, we still have an unused area of about 500m², serving as expansion reserve for our future growth.

Our new company building in Pfungstadt is more than just a change of location; it is a statement of our commitment to innovation and excellent service. We are proud to continue our history in a new place and look forward to shaping the next 50 years at this inspiring location.

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PPMS DynaCool user webinars in February 2024

The next QD user workshop will take place in February 2024. This workshop will treat the PPMS DynaCool and the use of measurement options like VSM, thermal capacity, electro transport etc. This The user training will be held online. We will present the basics of the systems and common measurement options and will give presentations full of useful information for users. Topics include sample mounting, sequence optimization, data evaluation and more. The webinar is particularly suited for new users. Nevertheless, we always welcome participating professionals. All presentations will be held in English. There will be room for questions and discussions on user topics and measurement data. You can find the exact dates and the registration form on our website.

qd-europe.com/events

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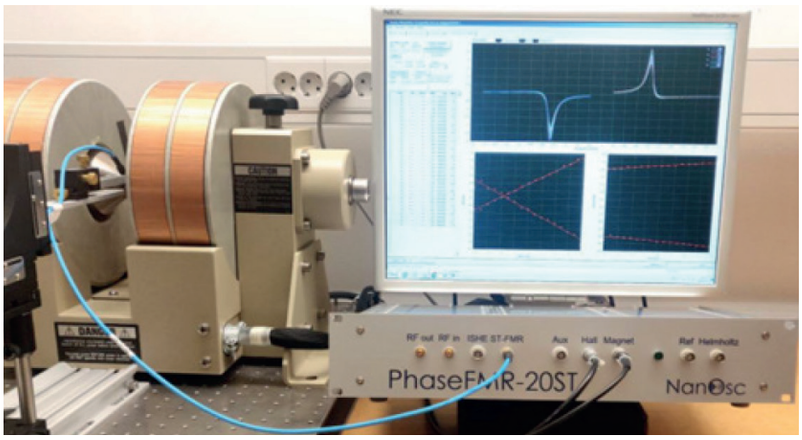
New spin-torque ferromagnetic resonance spectrometer

NanOsc have extended their portfolio by an FMR with spin-torque technology ST-FMR.

Broadband FMR is suited particularly well for the investigation of magnetic thin films which are used in magnetic memory, sensors, logic and in microwave signal processing. This application is part of spintronics and magnonics.

Broadband ST-FMR allows the analysis of spin-orbit torques. This is normally seen in ferromagnetic or heavy metal structures. Such an analysis is used in SOT-based magneto-resistive random access memories (MRAMs) and SOT-based spin-Hall nanooscillators (SHNOs) for wireless on-chip microwave communication and neuromorphic computing.



The ST-FMR is a turnkey spectrometer with user-friendly software. It comprises an integrated HF source, a bias current source, detectors and lock-in. It calculates the effective magnetization (M_{eff}), anisotropy (K), gyromagnetic ratio (γ), damping (α) and the inhomogeneous broadening (ΔH_o). ST-FMR adds the extraction of the spin-Hall angle (SHA) and the damping- and field-like torque efficiency (DLTE and FLTE).

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FusionScope wins the R&D 100 Award in the Analytics & Testing category

Quantum Design is pleased to announce the recognition of its new correlative AFM/SEM microscopy system, FusionScope, with the R&D 100 Award in the category of Analytics and Testing.

The R&D 100 Award annually honors the most innovative new products in the field of science and technology. The award is based on technical significance, uniqueness, and utility compared to competing products and technologies, and it is granted by an independent jury.

Stefano Spagna (Vice President for Strategy and Innovation, Quantum Design Int.) commented, "We are very grateful for the R&D 100 Award. The FusionScope is an example of Quantum Design's recent efforts to bring technological innovation to scientific research. The Quantum Design team saw the opportunity to create something unique in the field of microscopy — the first truly integrated correlative microscope that seamlessly combines AFM and SEM."

"The FusionScope offers users a completely unique approach to performing correlative AFM and SEM measurements," explains Chris Schwalb, COO of Quantum Design Microscopy. "Seeing the AFM cantilever tip in real-time and positioning it with nanometer accuracy using the SEM allows for experiments and measurements that were simply not possible before. The entire development team is very proud of this recognition."

The award ceremony will take place on November 16 in San Diego as part of the R&D 100 Awards presentation. If you would like to learn more about the features and applications of FusionScope, visit us on our website at www.fusionscope.com.

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User report – Monochromatic light sources for defect characterisation

Introduction

The Helmholtz-Zentrum Dresden-Rossendorf (HZDR) operates internationally renowned large-scale research facilities and serves as a coordinator and partner in numerous scientific collaborations and projects. A significant portion of the scientific infrastructure at HZDR is made available to external researchers from academia and industry.

The ELBE Center for High-Power Radiation Sources, within this framework, provides a highly sought-after international infrastructure for utilizing various types of secondary beams — both electromagnetic radiation in the form of coherent infrared radiation with very high field strengths, and particles such as neutrons and positrons. The positron beam generated through pair production with bremsstrahlung from the superconducting electron accelerator ELBE (short for Electron Linac with high Brilliance and low Emittance), referred to as pELBE, is used for characterizing atomic defects in thin layers up to 1 µm in thickness, with energies ranging from 0.5 keV to 30 keV.

Positron Annihilation Lifetime Spectroscopy

When positrons, the antiparticles of electrons, are implanted in matter, they naturally annihilate within short periods with the electrons present in that location. However, the average lifetime of positrons is strongly influenced by the local electron density at the annihilation site and can range from a few 10 ps for single vacancies in metals to several 100 ns during the formation of positronium, an analog state of the hydrogen atom. The goal is to characterize atomic defects such as single, multiple, or cluster vacancies, as well as dislocations and grain boundaries, in a depth-dependent manner through precise determination of positron lifetimes in matter. The method achieves sensitivity in the ppm range due to the electrostatically effective attraction of vacancies (the positive charge of atomic nuclei is missing here).

Manipulation of the Charge State of Defects

Defects, especially in semiconductors, are not always in a negatively charged state. Monochromatic light can be used to selectively influence this charge state. In the case of pELBE, an intense Xe arc lamp (Bentham B-IL75E-P) with a wavelength range of 200 nm to 1500 nm is employed to selectively introduce electrons into intraband states, making defects visible to positrons. In addition to semiconductors, the charging of defect states in AlN and photochromic oxyhydrides for applications in glass coating has also been investigated.

A monochromator (Quantum-Design MSH-300) with fiber optics is used to focus the light source on the sample material in an ultra-high vacuum system. The controllability of the monochromator allows integration into automated data acquisition for in-situ measurements of positron annihilation lifetimes.

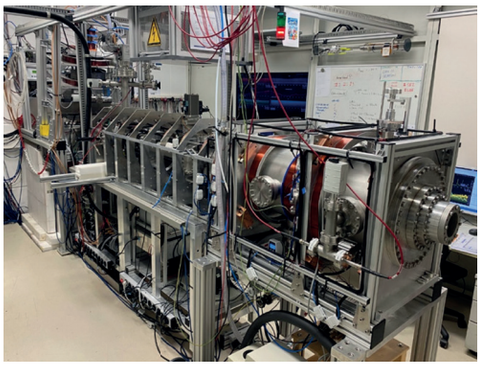

Fig. 1: The high-intensity positron beam at the ELBE centre for high-power beam source for defect characterisation and porosimetry

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Next conference on nanomechanics coming up!

In the Spring of 2024, our partner MicroMaterials will hold their first real-life conference on nanomechanics für academic and industrial research since the Corona pandemic. The conference will take place in Birmingham, center of innovation and modern industry in the British Midlands. This conference provides the opportunity for exchange between researchers and gives the chance to learn more about the exciting new developments from MicroMaterials in the field of high-temperature applications and the new "Randomized Impact Technique" for the simulation of erosive wear in the nano and micro range.

Further details are published on our website and on LinkedIn.

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Important – New MeasureLINK Version – Please update!

New Lake Shore MeasureLINK software has been published in June. We recommend you download the latest version to profit from all the new features. This update is free of charge to all current license users. It is not necessary to renew the MeasureLINK activation code.

MeasureLINK is available as free trial version and for one-time purchase. The software controls Lake Shore temperature controllers and measuring systems and enables automated measurement procedures. It also facilitates the integration of third-party devices via predefined drivers and scripting features.

Check out this page for more details on MeasureLINK: https://bit.ly/3qvaOMK

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