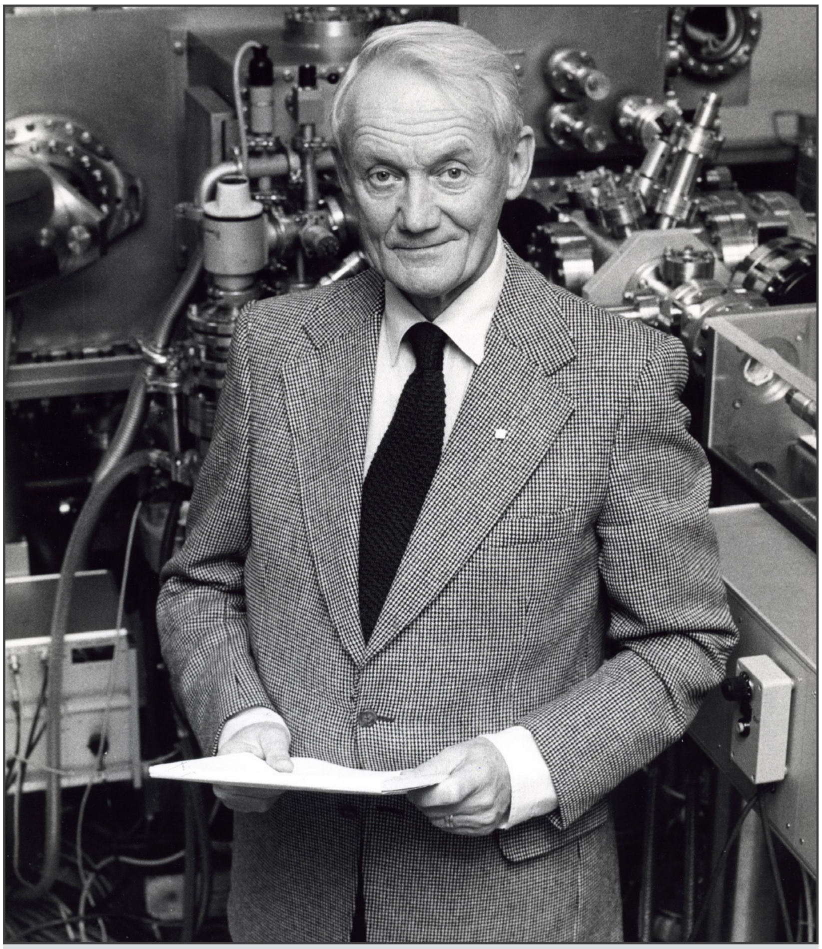
Scienta Omicron - Celebrates 40 Years of Innovation, Product Development and Industry Leadership

Dear Valued Customers, Partners and Collaborators,

Welcome to the Scienta Omicron Newsflyer for Fall 2021.

40 years ago in 1981, our co-founder Prof. Kai Siegbahn was awarded the Nobel Prize in Physics for developing the method of Electron Spectroscopy for chemical analysis (ESCA/XPS) – thereby creating the starting point for Scienta. Since then, the technology has been extended to incorporate Molecular Beam Epitaxy, Thin Film Deposition, Scanning Probe Microscopy Systems and a wide range of components.

Keeping our tradition of pioneering and leading Surface Science and Nanotechnology innovation, Scienta Omicron is excited to release the **revolutionary DFS30 analyser** – a ground-breaking and patent pending Electrostatic 3D Focus Adjustment technology. We are also launching our new **CREATE Platform** – a configurable platform delivering your unique UHV Systems.



Prof. Kai Siegbahn in 1981. Av Jan Collsiöö - [1] Dutch National Archives, The Hague, Fotocollectie Algemeen Nederlands Persbureau (ANEFO), 1945-1989, CC BY-SA 3.0 nl, https://commons.wikimedia.org/w/index.php?curid=20426460

In this addition of the Newsflyer you can also read about:

- The installation of a Materials Innovation Platform (MIP) for epitaxial growth and in-situ analysis of 2D semiconductors at University of Nottingham
- PEAK acquisition control software
- Research results where physicists and chemists from JLU Giessen have developed an approach for constructing covalent organic nanoarchitectures using scanning probe microscopy
- The first LT STM in south America at Nanobiomaterials Lab, Universidad Técnica Federico Santa María, Chile
- Recent research using the HAXPES Lab,
- The resumption of Scienta Omicron´s travels to support our customers around the world.

We thank you, our customers, partners, and collaborators, for your continued and unrelenting support over the past year. We are proud to be part of the international research community and look forward to continuing to support your research with our innovative instruments.

Yours sincerely,

Scienta Omicron Team

DFS30

Stay focused, save time

The DFS30 analyser features ground-breaking Electrostatic 3D Focus Adjustment technology - a major advancement in replacing imprecise mechanical movements with electronic precision and repeatability. This provides significantly improved workflow, speed, and reproducibility when optimising experimental conditions. High quality ARPES measurements, particularly µARPES and nanoARPES, require optimised alignment of the photon spot, sample, and analyser focal point. The DFS30 simplifies this alignment with electronic adjustment of the analyser focal point.

The focus on µARPES and nanoARPES in conjunction with high resolution measurements has highlighted the challenge of obtaining optimal alignment. Without optimal alignment deflection mode measurement performance is reduced (see Figure 2). Electrostatic 3D Focus Adjustment enables shifting the analyser's focus in 3D to the photoelectron emission spot, leaving the sample and photon spot mechanically static. This saves hours of alignment and preserves sample surface quality and lifetime for measurement.

The electronic shifting of the analyser focal point requires dynamic lens tables for deflection, angular, and transmission modes. These lens tables are now calculated in real time based on a set of calibrated and adjustable sliders.

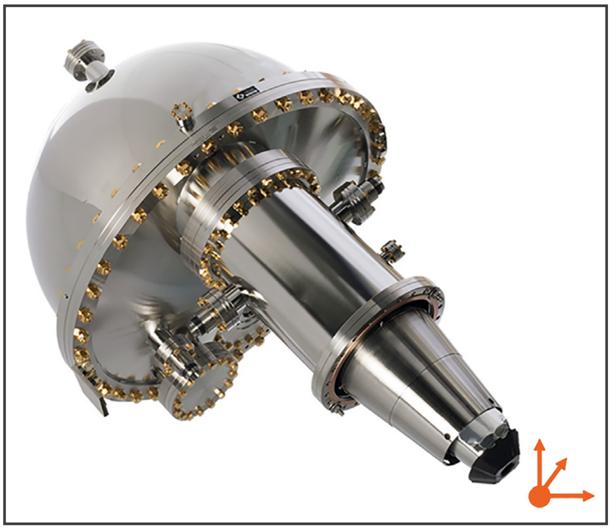


Figure 1: From the electron analyser innovators: The DFS30, the new standard for angle resolved photoelectron measurements, is equipped with Electrostatic 3D Focus Adjustment. Real time calculated lens tables adjust and shift the analyser focal point to the emission spot on the sample, ideal for small spot µARPES measurements.

DFS30

- Electronically shift the analyser focal point to the photoemission spot
- Increase effective sample life-time through fast and precise alignment
- Electrostatic 3D Focus Adjustment in X, Y, Z (WD) for best results
- Upgrade from DA30-L available

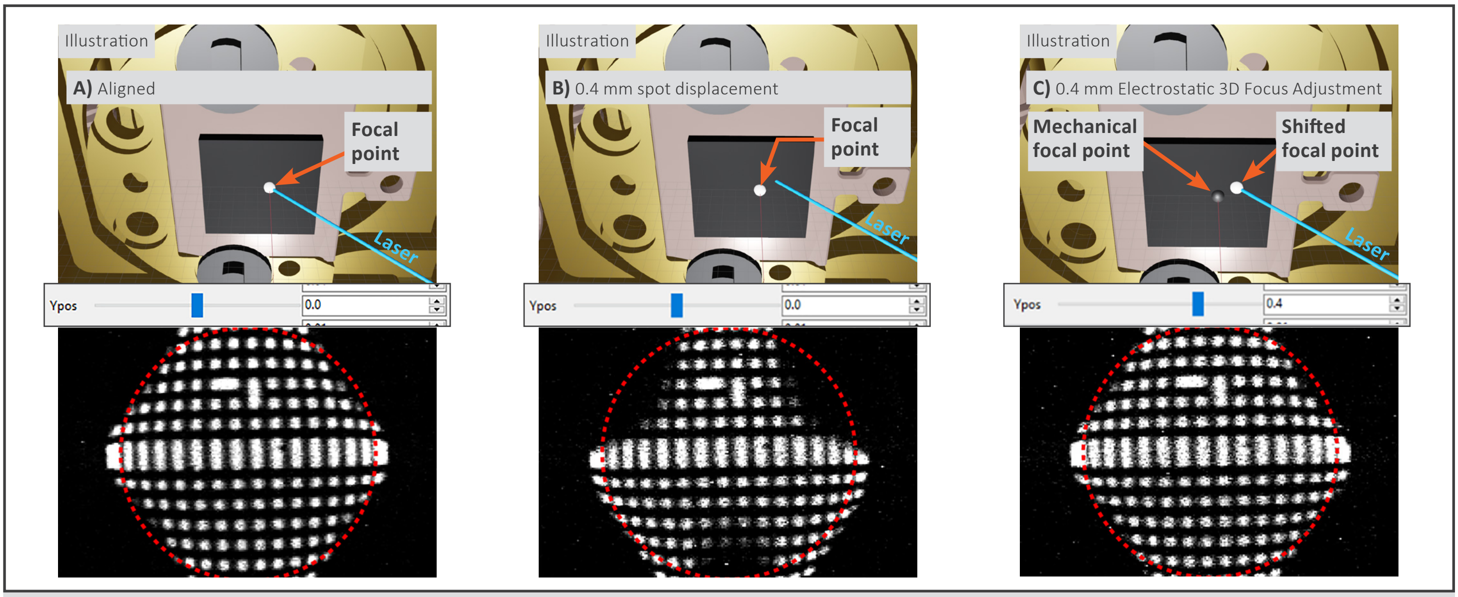


Figure 2: Electronic 3D Focus Adjustment results: A) shows a well-aligned situation with the analyser focal point and photon source overlapping. The complete analyser acceptance angle, indicated by the red circle, is filled with accurate intensity. B) The 0.1 mm excitation spot is misaligned by 0.4 mm. The corresponding measurement shows shadowing and asymmetry between the upper and lower half. C) Using Electrostatic 3D Focus Adjustment, the analyser focal point is easily shifted with a slider to the photoelectron emission spot without any mechanical movement. The corresponding measurement shows the full accurate data expected for a well aligned situation. The grey point indicates the original focus position, without Electrostatic 3D Focus Adjustment.

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CREATE

Scienta Omicron Launches CREATE – a Configurable Platform Delivering Your Unique UHV System

We are pleased to announce CREATE, Scienta Omicron's new configurable platform for UHV system design. The CREATE platform combines modules within an established framework to form a robust system solution with guaranteed specifications.

Designing a system based on the CREATE platform with your Scienta Omicron expert provides clear decision pathways for features and specifications. The inherent design logic embodied in the CREATE platform guarantees not only the performance expected of a Scienta Omicron instrument, but a robust, easy-to-use and maintain UHV system. CREATE gives immediate access to system layout drawings, site preparation documents and system acceptance specifications, accelerating the process from concept to first experiments.

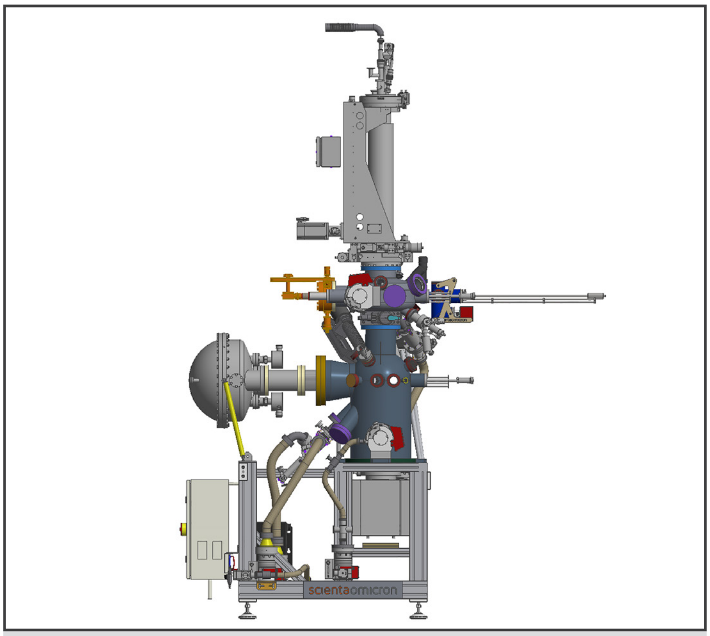
Starting now, the Lab10 MBE system and the ARPES Lab system can be built based on the CREATE platform. Next year the CREATE platform will expand to include additional system-level products for SPM, MBE and electron spectroscopy techniques.

Systems based on the CREATE platform have shorter lead times than fully customised systems and still efficiently adapt the design to an individual's experimental requirements. In fact, there are more than a million unique ways to configure a Lab10 system based on the CREATE platform!

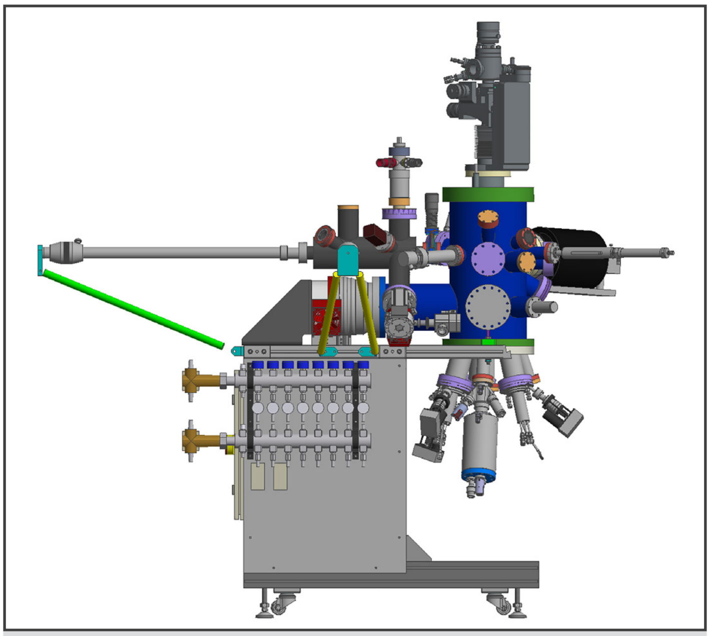
The continual evolution of the CREATE platform, based on feedback from our large customer base, secures best-in-class UHV component technology (pumps, controllers, wobble sticks etc) at any given time.

By developing and deploying this next generation platform, Scienta Omicron increases the overall capacity for delivering both made-to-order and CREATE platform systems to customers around the world.

For more information about CREATE please conntact your Scienta Omicron Sales Representative.



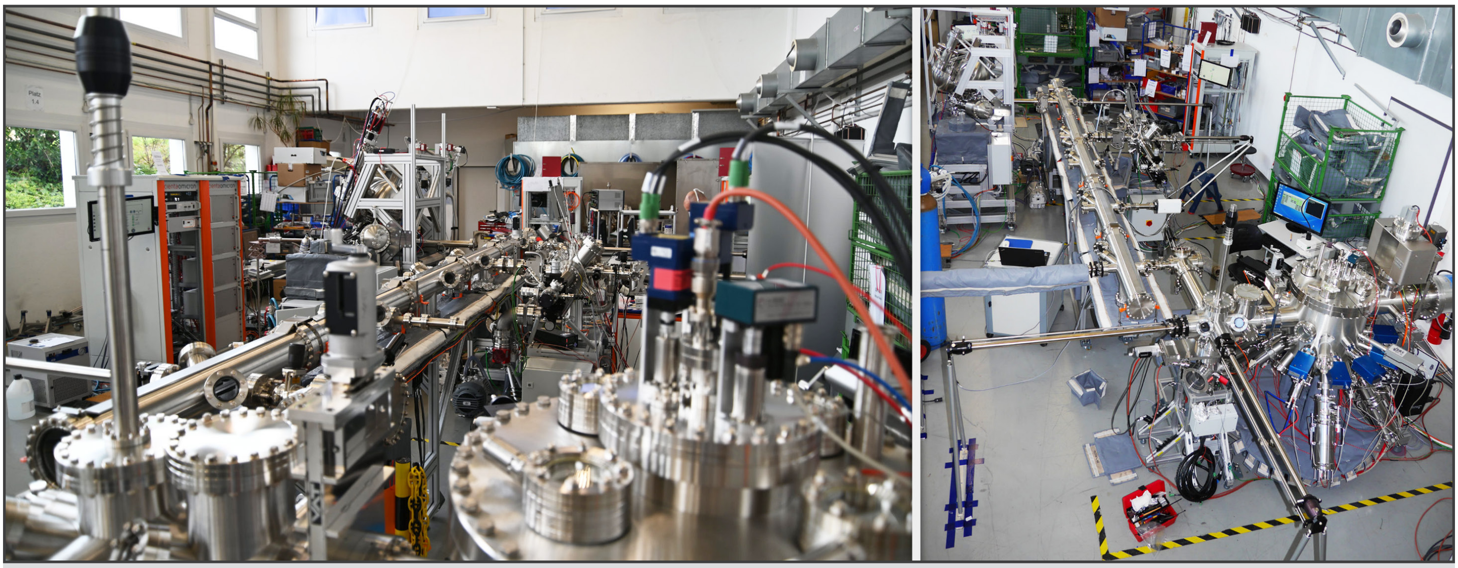
ARPES Lab: drawing generated by CREATE platform



Lab10 MBE: drawing generated by CREATE platform

Delivered to University of Nottingham

MIP for Epitaxial Growth and In-situ Analysis of 2D Semiconductors

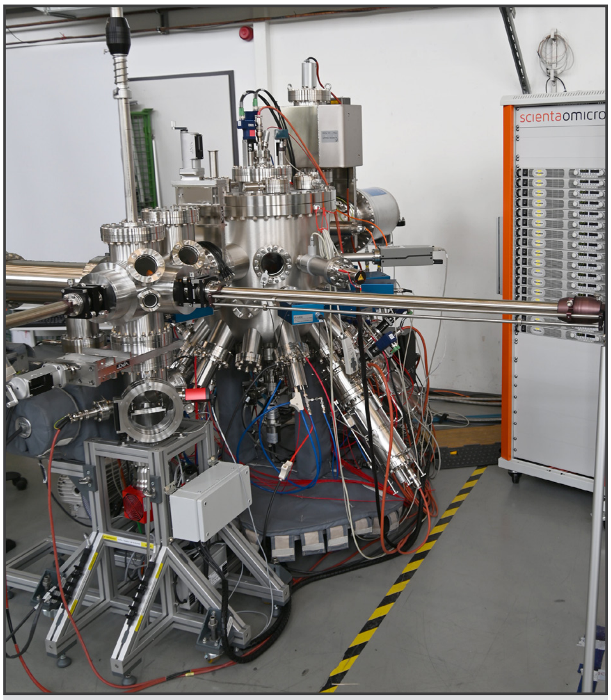


The new Ultra-High Vacuum (UHV) Materials Innovation Platform (MIP) combines a PRO-75 MBE for thin-film synthesis, a NanoESCA module for band structure and chemical analysis, and a Multiprobe Prep module with VT SPM for surface morphology studies. All modules are interconnected by a Linear Transfer Line (LTL). Photos from the factory in Taunusstein during the final acceptance test.

A new facility (EPI2SEM) is established at the University of Nottingham, which focuses on the epitaxial growth and in-situ analysis of a new generation of 2-dimensional semiconductors. These materials have the potential to transform many of the technologies we see around us and use every day, due to their unique electronic properties (tuneable band structure, IR-VIS-UV broad optical absorption, electron correlations, high electron mobility, etc.). They also have the versatility for a wide range of applications (digital flexible electronics, optoelectronics, quantum technologies, energy, etc.). The facility provides the capability to grow novel semiconductors with atomic layer precision in a clean ultra high vacuum system with fully-characterised electronic, chemical and morphological properties.

The core element of the new facility is the new Materials Innovation Platform (MIP) delivered by Scienta Omicron including a PRO-75 MBE, a NanoESCA, and a Multiprobe Prep Module with VT STM. The in-situ transfer between the modules is realised via a UHV Linear Transfer Line (LTL). The NanoESCA instrument can be operated in several complementary electron spectroscopic modes. Measurements in PEEM, µ-ARPES, and XPS mode at the same spot on the sample are enabled by the high precision, low vibration sample stage reaching temperatures below 20 K.

Read more about the EPI2SEM facility here:
https://www.nottingham.ac.uk/physics/news/2.9-million-epsrc-award-for-2d-research.aspx



PRO-75 MBE configured for chalcogenide growth with cryopump and ion pump. The deposition chamber is designed to allow homogeneous epitaxial growth on samples up to the size of a 3inch wafer. A dedicated load lock is used to introduce 3inch carriers. Flagstyle sample holders can be separated from the 3inch carrier and transferred in-situ to the NanoESCA and VT SPM modules via the LTL.

Upgrade to PEAK

Electron Spectroscopy Control and Acquisition Software

Upgrade your Scienta Omicron analyser to PEAK acquisition control software. PEAK comes with a modern software architecture, that offers improved performance for data acquisition, work flow, and live visualisation of data. The modular design and the modern network based application programming interface (API) facilitate integration of the analyser in external control systems.

The PEAK Graphical User Interface (GUI) is accessed through a browser and uses network communication to control the analyser hardware. Multiple browser tabs of the GUI can be distributed across multiple screens, ensuring all important information for an experiment can be displayed. The main view, as shown in Figure 2, can be configured to show the camera's raw monitor without any image processing or corrections applied. A second optional display shows the spectrum monitor with the signal mapped into the correct spectral channels. The analyser settings are always visible to the right and continuously updated during the experiment.

In PEAK, data visualisation is independent of ongoing acquisitions and is therefore fully flexible. Selecting a specific slice of the multidimensional data is done by defining the axes and ranges to be visualised. One can switch between 1D and 2D representation.

For instance, it is possible to display an ongoing deflection scan as a θ_x, θ_y image for a selected slice of energy. With the display continuously updating with new data, it is possible to monitor the signal to noise ratio with each consecutive loop over θ_y deflection and stop when ready.

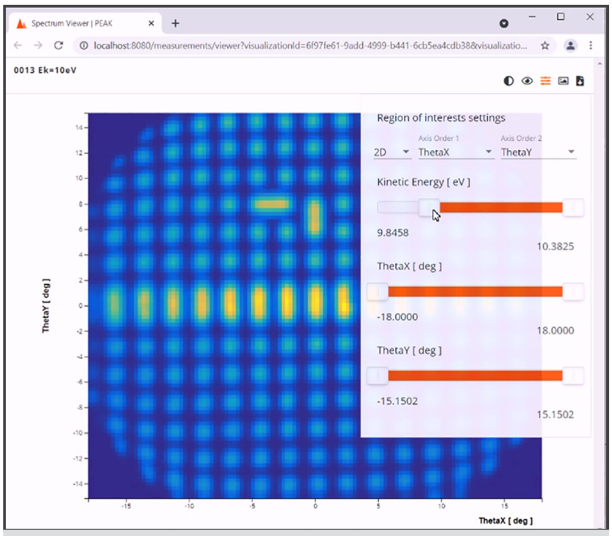


Figure 1: Data visualisation is done on the fly and can be applied to a selected slice or the complete data range. The visualised data is continuously updated as the measurement progresses allowing to explore data without interfering with the acquisition.

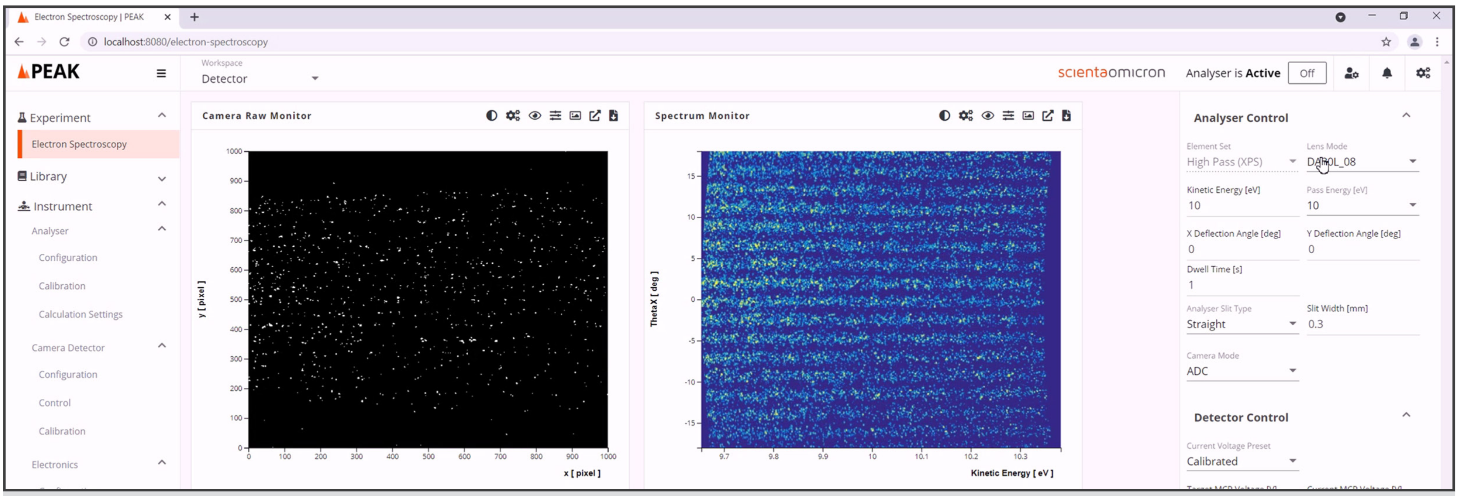


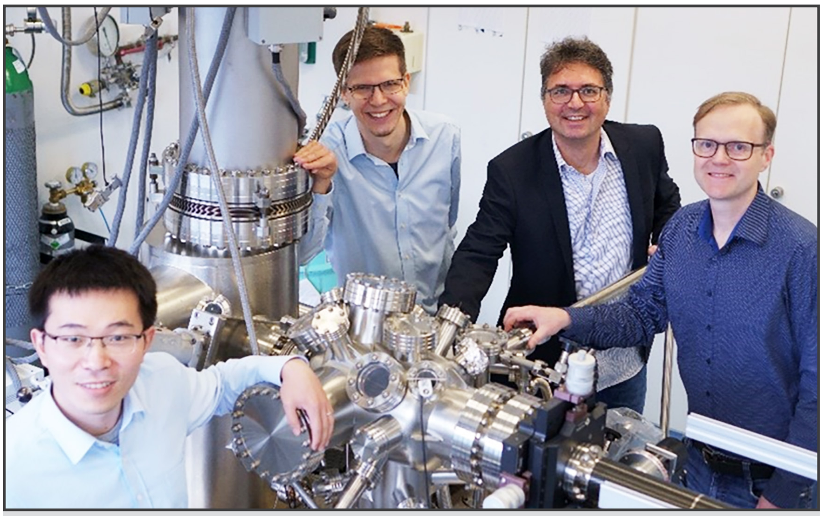
Figure 2: The PEAK graphical user interface controls the analyser. Data windows shown can be adapted to the individual preferences. A camera raw monitor is available without any image corrections, as well as a spectrum monitor with image corrections applied. Displaying for example a running average of the data or changing the colour scheme for better visualisation is supported. The analyser control settings are conveniently displayed to the right and easily changed while setting up a measurement. Multiple interfaces can be opened at the same time and displayed across multiple screens.

Handmade Nanoarchitectures

Tailored Organic Nanostructures can now be constructed Molecule by Molecule on a Salt Surface Using the Tip of a Scanning Probe Microscope.

Physicists and chemists from JLU Giessen developed an approach for constructing covalent organic nanoarchitectures molecule by molecule on a salt surface using scanning probe manipulation. The relatively inert salt surface ensures the precise alignment of the molecular building blocks in the plane but keeps them movable. The sharp tip of an atomic force microscope, which has only a single atom or molecule at its apex, serves as their second tool. With this “finger“ three successive reaction steps are performed by applying short voltage pulses between the surface and the AFM tip (see figure 1):

1. Activation of the molecular precursors to enable a subsequent intermolecular coupling reaction.
2. Bringing the activated building blocks on the surface into close proximity.
3. Inducing the chemical reaction between the two molecular educts, which leads to the formation of a covalent bond.



On-surface synthesis team of the Justus Liebig University in Giessen. From left to right: Qigang Zhong, Alexander Ihle, Andre Schirmeisen and Daniel Ebeling.

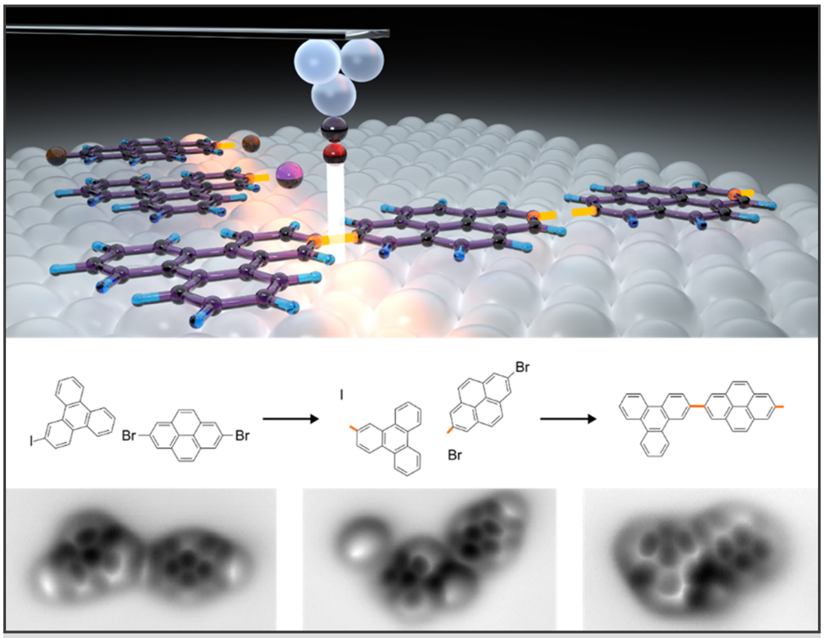


Figure 1: Constructing covalent organic nanoarchitectures via scanning probe manipulation. The halogenated precursors are adsorbed on an inert NaCl surface, which ensures their alignment in the plane but keeps them movable. The AFM tip is used as a “finger” for inducing the subsequent reaction steps by short voltage pulses. The activated and newly formed chemical bonds are shown in orange.

With this approach the researchers are addressing a question that has already been formulated in 1959 by Richard P. Feynman and that led to today‘s field of nanotechnology: “What would happen if we could arrange the atoms one by one the way we want them”. In the early 1990s K. Eric Drexler had the even keener vision that in the future, tiny machines could accomplish this task. Such machines, the molecular assemblers, could create almost arbitrary nanoarchitectures (provided that they are chemically stable) and equip them with tailored functionality.
However, these ideas were heavily debated over many years. Richard Smalley, winner of the Nobel Prize for Chemistry in 1996, came up with two substantial counter arguments.
The first one is that the “fingers” (or tools) of such machines could never align the individual building

blocks (atoms or molecules) precisely enough since the “fingers” are of finite size (they are themselves composed of atoms or molecules). The second argument is that the building blocks as well as the products would stick to the “fingers” because of large adhesion forces. Smalley called these fundamental objections the “fat finger problem” and the “sticky finger problem”.
The new approach circumvents both problems. The inert salt surface acts, so to say, as a “non-sticky hand” and the sharp AFM tip serves as a “non-fat finger”. This opens ways for creating new organic nanomaterials and systematic studies of the relationship between their structures and properties. Thereby, it will enable a targeted manipulation of the functionalities of such nanoarchitectures, which is particularly interesting for applications in electronics devices such as organic field effect transistors (OFET), organic light-emitting diodes (OLEDs, e.g. for smartphone displays), or organic solar cells. Via this approach new fundamental insights into the mechanisms of molecular reactions on surfaces can be gained, which is important for the emerging field of on-surface synthesis.

The full article in Nature Chemistry can be accessed for free here:
https://www.nature.com/articles/s41557-021-00773-4

Original publication:
Qigang Zhong, Alexander Ihle, Sebastian Ahles, Hermann A. Wegner, Andre Schirmeisen and Daniel Ebeling: Constructing covalent organic nanoarchitectures molecule by molecule via scanning probe manipulation. Nature Chemistry (2021)

The First LT STM in South America

Nanobiomaterials Laboratory, Universidad Técnica Federico Santa María, Chile

Low Temperature STM, an essential tool for most of the nanomaterial and nanotechnology research centres in Europe, Asia, and USA, has not yet been available in South American universities. However, that is about to change with the first LT STM being delivered to the Nanobiomaterials Laboratory at the Universidad Técnica Federico Santa María in Valparaiso, Chile (funded through the FONDEQUIP initiative of the Chilean Ministry of Science).

Prof. Carolina Parra Gonzalez with colleagues from the Nanobiomaterials Laboratory

Prof. Carolina Parra Gonzalez, director of the Nanobiomaterials Lab comments: “I am convinced the Scienta Omicron LT STM system will place nanoscience in Chile at a high level, comparable to and competitive with international research centres. It will become an extremely useful tool for the local and international “nano”-community comprised of physicists, chemists, and biologists—allowing many interdisciplinary collaborations.”
The addition of the Scienta Omicron LT STM will profoundly advance the Nanobiotechnology group’s current work on the growth and study of relevant quantum materials including topological insulators, superconductors, dichalcogenides, heterostructures and other low-dimensional systems. Before now, this has only been possible thanks to a collaboration with researchers at Stanford University in the USA.

Recent Research Using the HAXPES Lab

Laboratory-based Hard X-ray Photoelectron Spectroscopy for Fundamental and Industrial Research

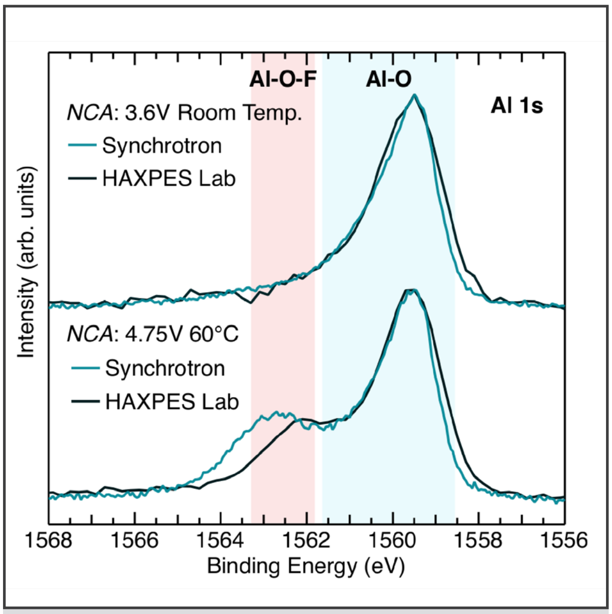


Figure 1: HAXPES measurements of the Al 1*s* for commercial $LiNi_{0.8}Co_{0.15}Al_{0.05}O_2$ electrodes using both synchrotron (beamline I09 at the Diamond Light Source in UK, 6 keV) and HAXPES Lab (9.25 keV). Data reproduced from Ref.2

Hard X-ray photoelectron spectroscopy (HAXPES) is a powerful technique to observe chemical and electronic states of atoms buried inside materials. In their recent paper, T. Hashimoto, A. Regoutz, N. Barrett, and L. F. J. Piper et al. reviewed research using the HAXPES Lab[1)].

A direct comparison of the measurements using a synchrotron light source and the HAXPES Lab is made for a layered oxide cathode, which is used in lithium-ion batteries[2)]. The spectra in Figure 1 show excellent agreement between the two instruments, and differences in the chemical shifted peak are interpreted by the enhanced probing depth of the HAXPES Lab compared to the synchrotron light sources. The HAXPES Lab is an attractive option not only for scientists but also for industrialists needing rapid answers for research and development.

Reference:
1) T. Hashimoto et al., Vacuum and surface science (to be published)
2) Z. W. Lebens-Higgins et al., Scientific Reports 9, 17720 (2019).

Dr. Louis F. J. Piper, is a Professor at University of Warwick and Visiting Professor at Binghamton University, says:

"HAXPES measurements are no longer restricted to Synchrotron facilities, allowing us to look at the important chemistry of the extended subsurface regions of real battery electrodes in a laboratory setting."

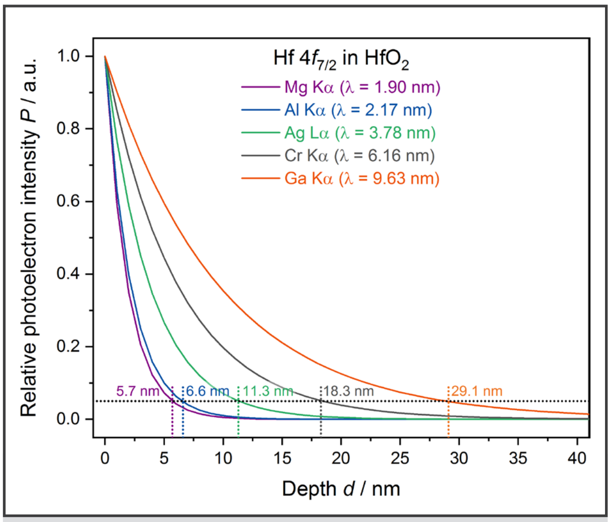


Figure 2: Relative photoelectron intensity *P* as a function of depth *d* for the Hf $4f_{7/2}$ core level in HfO_2 using available laboratory X-ray sources[1]. The legend gives the inelastic mean free paths λ for Hf $4f_{7/2}$ at different excitation energies.

About the HAXPES Lab:

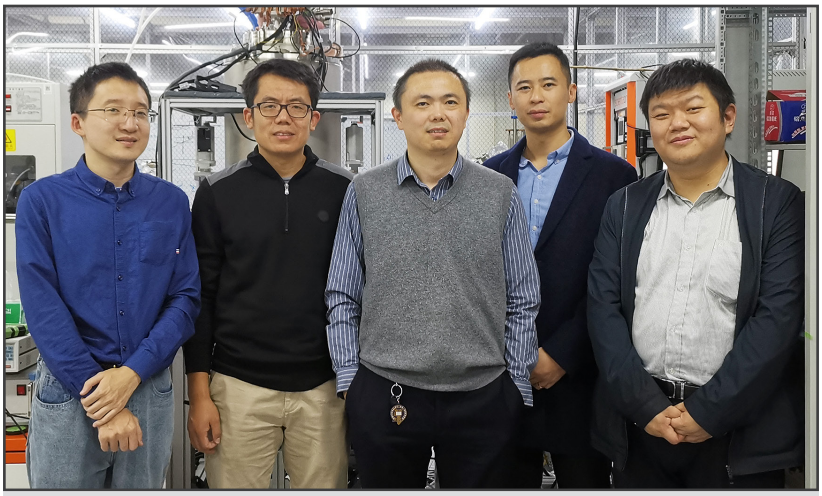
HAXPES allows the study of bulk materials, buried layers and interfaces, as well as samples without the need of extensive surface preparation or destruction, due to the increase in probing depth with increasing photon energy (Figure 2).

The instrument profits from a sophisticated design where a high-flux, monochromated Ga liquid MetalJet 9.25 keV, X-ray source is combined with the wide acceptance angle electron analyser EW4000. Orienting the X-ray source with respect to the analyser lens axis at 90° in combination with grazing incidence allows boosting the signal intensity. Owing to the large probing depth the device allows for operando investigation of electronic devices.

The World is Opening Up!

Scienta Omicron is Resuming International Travel to Support our Customers Around the World

We are packing our bags and scheduling trips to visit our customers and attend conferences across Europe, Asia, Oceania, and North and South America. Scienta Omicron's customers are crucial to our company. Meeting with you is not only important for our service engineers to perform upgrades and maintenance, but also for us to hear about your research needs. Our customers are who drive us to research and design better solutions, new functionality, and ultimately new products that enable your research into the future.
During our upcoming scheduled international travel, our Services team look forward to performing upgrades and required maintenance to have your system running as effectively as possible. Our Sales team also look forward to travelling to site to delve into and discuss which functionalities and instruments will best support you.
During the pandemic we have been able to provide the most essential services through our regional Sales and Service teams based in the US, China, Korea and Japan. Now, through these teams, and our staff based in Sweden and Germany, we will be able to again fully utilise our global presence again to reach you as timely as possible.
During the pandemic Scienta Omicron prepared for the future. We have grown our team in sales and service, launched new products, developed new service and training options, and refined our ability to provide remote support. We look forward to take advantage of the work we have done during the pandemic into the future, including continuing to offer remote support sessions when it is the best and most timely options for customers.
During 2022 we are excited to welcome customers to visit us at our Technology Centres in Uppsala, Sweden, and Taunusstein, Germany. Our dedicated and growing team is looking forward to meeting you face-to-face as soon as possible either at conferences or on-site at your laboratories.



The Polar STM at ShanghaiTech University, China.
From left to right: Xianchi JIN (Scienta Omicron), Shengyong QIN (University of Science and Technology of China), Aidi ZHAO (ShanghaiTech University), Shanwei HU (Scienta Omicron), Hui ZHANG (University of Science and Technology of China).

Mr. Nakaguchi (Scienta Omicron) and Dr. Yoshimura (Hyogo Science and Technology Association) with the HAXPES Lab at the Hyogo Science and Technology Association, Japan.

Yours sincerely,

Susanna and Tobias

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