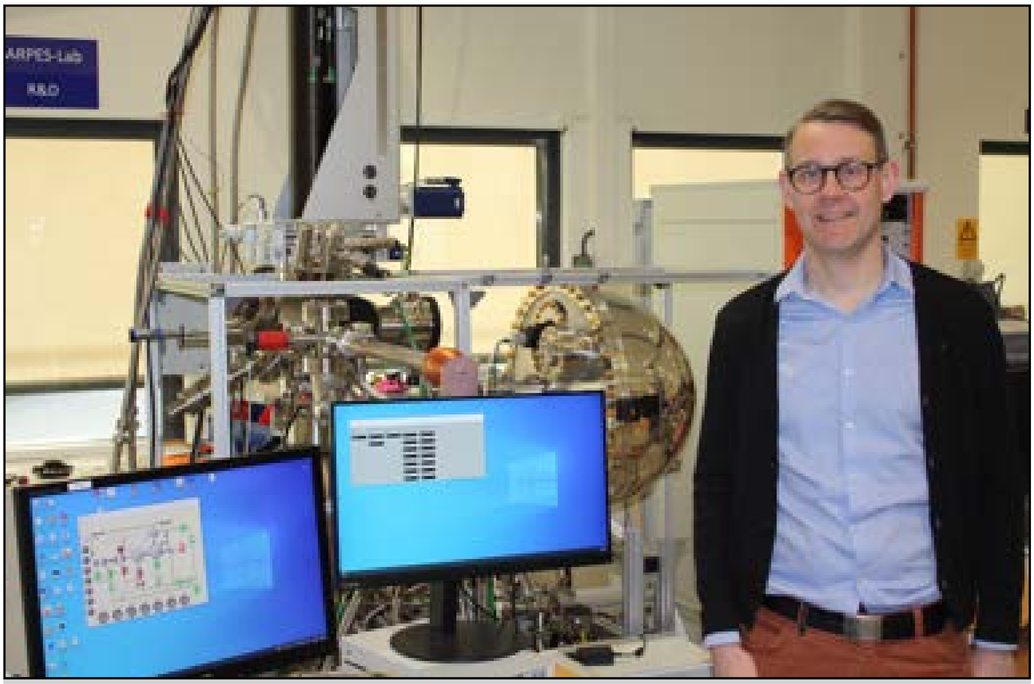
A NOTE FROM OUR NEW CEO

– I look forward to solving future challenges with our great team

– March 1st 2022 was my first day as president of the Scienta Scientific group. I joined the then much smaller Scienta ten years ago and it has been a privilege and a pleasure to watch and contribute to the company's development into its current shape. I started off in the sales department, and in a sense I'm still there; I strongly believe that the ability of any company to fill a customer need and to provide customer value is fundamental to its success. The ability to develop, configure, produce, install and service our products are of course equally important, but if our offering do not strike a chord with our customers, the rest doesn't really matter.

– I am very proud of our two business areas. Scienta Omicron offers ultra-high vacuum systems to support creation and analysis of advanced materials. Scienta Envinet offers radiation protection networks to support safe and peaceful use of nuclear applications.

Henrik Bergersen, President Scienta Scientific Group

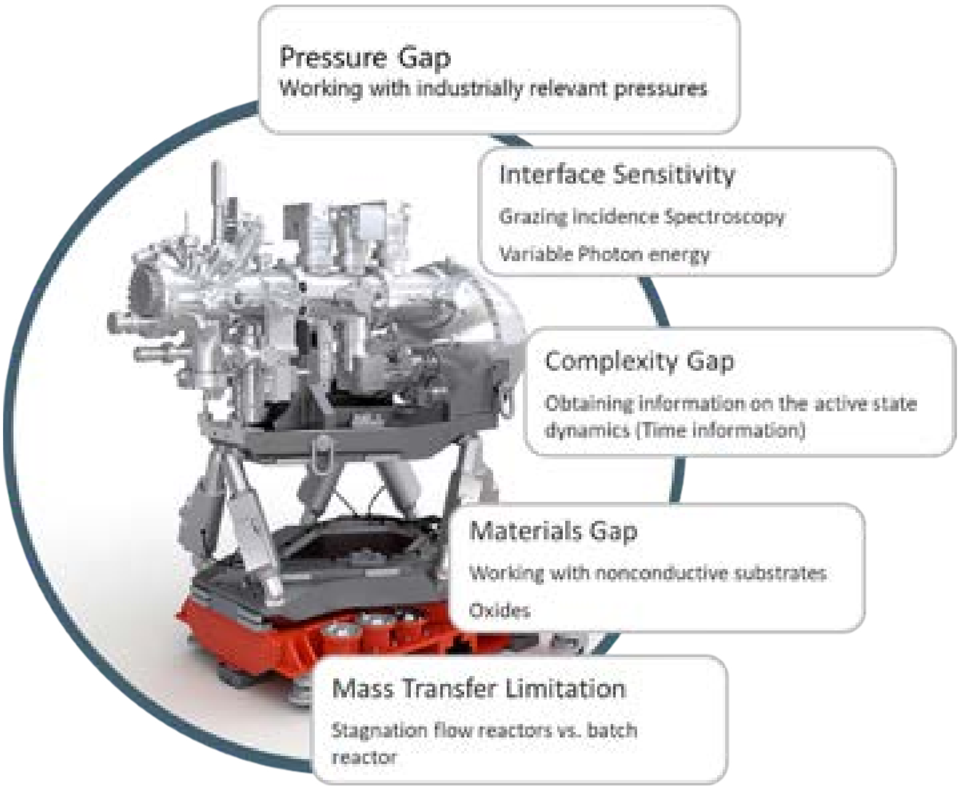


Henrik Bergersen in front of an ARPES Lab

– The greatness of any business is ultimately owed to the greatness of its people. Today, we are more than 230 people across the globe. The hard work and dedication of these people, all day every day, is the reason we have come this far.

– I am very much looking forward to continuing the journey together with this great company. In the years to come there will be many customer challenges to take on, products to develop and services to perform. With cleverness, dedication and teamwork, there is no limit to what we can achieve.

BAR XPS
Breakthrough Results



The successful investigation of catalytic reactions on a molecular level is traditionally limited by some of the biggest challenges in ambient pressure XPS (APXPS). Here the pressure, materials and complexity gaps are the most prominent. These gaps describe the inability to investigate a system under realistic conditions. The BAR XPS addresses this in a unique way and has allowed scientists to push applications to the next level.

Using the BAR XPS, scientists have successfully achieved some remarkable results:

Blomberg et al. [1] have followed the CO oxidation reaction on Pd (100) at a pressure of up to 1 bar in combination with temperature dependent ramps up to ca. 500 °C. Owing to a so called virtual cell approach, the mass transfer limitation was pushed to a completely new regime.

Another example is that of Knudsen et al. [2], who could gain a detailed understanding on the oxidation and reduction behaviour of Pd on a time resolution of 60 ms and operating pressures of 100 mbar, as seen in Fig 2. This was achieved using fast gas pulsing. AP-HAXPES at 9030 eV allowed Wang et al. [3] to probe deep below the surface, revealing information on sub-surface oxygen in Cu.

These results from the BAR XPS demonstrates how the biggest challenges in APXPS can now be addressed by the BAR XPS. Explore more in Ref. [4]

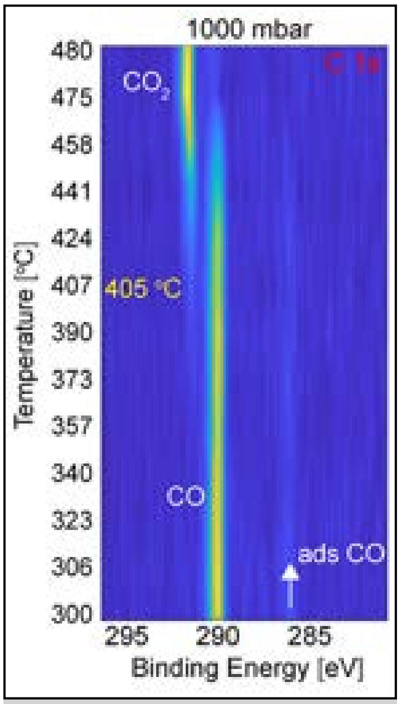


Figure 1: Temperature dependent APXPS of the C1s core level following the CO oxidation reaction at a total of 1 bar. Above 405 °C clear indications of CO_2 formation are seen. Reproduced from Ref. [1]

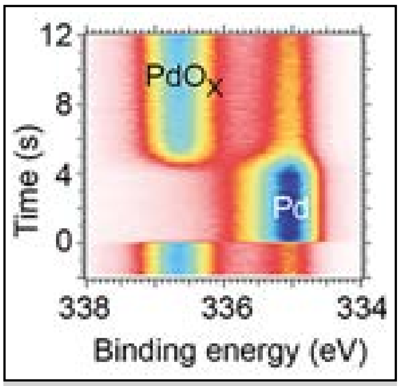
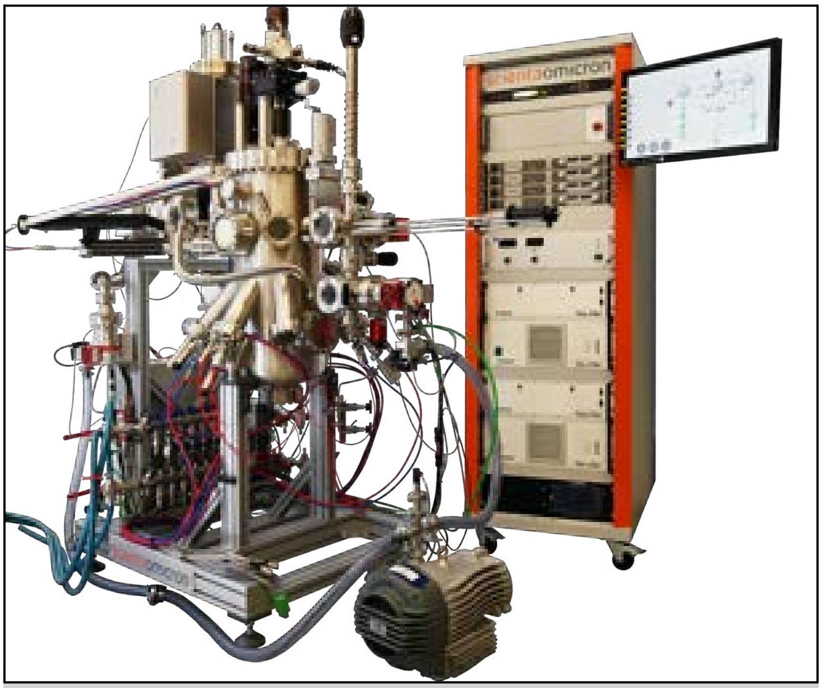


Figure 2: Time dependent investigation of the oxidation-reduction behaviour at 60 ms time resolution using stroboscopic APXPS and event averaging in Pd 3d core level. Reproduced from Ref. [2]

[1] Blomberg et al. ACS Catal. 2021, 11, 9128
[2] Knudsen et al. Nature Comm. 2021, 12, 6117
[3] Wang et al. Angew. Chem. Int. Ed. 2021, 60, 2
[4] Amann et al. Rev. Sci. Inst. 2019, 10, 103102

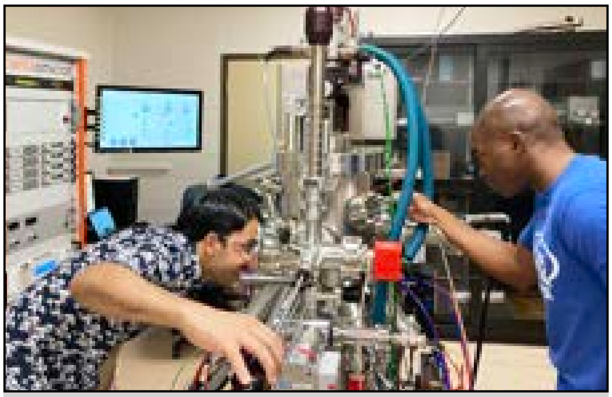
EVO COMPACT
MBE System for 2D Material Research



The EVO Compact system in a standalone configuration, with buffer and load lock chamber for flag style sample plates. It combines multi-pocket and vertical electron beam evaporators for co-deposition of transition metals with low vapor pressure.

EVO Compact advantages:

- Compact design optimized for 2D materials
- High power multi-pocket e-beam evaporator
- Proven UHV deposition process
- Local service, worldwide organization



EVO Compact system at Clemson University's Laboratory for Band-Engineered Quantum Systems (LaBEQ), USA. Dr. Kasra Sardashti is the first customer of our new EVO Compact system.

The new EVO Compact system has been specifically designed for researchers developing novel 2D material systems, such as transition metal dichalcogenides (TMDs) and complex hetero-epitaxy structures involving low vapor pressure or rare-earth elements. A multi-pocket electron beam evaporator enables the efficient deposition of multiple transition metals in this small-footprint system design.

The system is optimized for growth on flag style sample holders and offers features usually available in larger MBE systems. To maintain the lowest possible contamination level during growth, a full double-walled LN2 cryopanel is implemented. It acts as a cold trap for atoms and molecules hitting its surface and reduces overall heat load. The large pump ports provide the choice of various high rate vacuum pump configurations, including cryogenic pumps. These features, along with options for larger sample sizes, make the EVO Compact an ideal choice for UHV metallization tasks on wafers up to 2 inch diameter.

The source configuration is complemented by five DN63CF (O.D. 4.5") ports for conventional MBE sources. Longer growth campaigns are feasible as the maintenance cycle is extended by the larger crucibles available (nominal capacity up to 60 ccm in combination with a water-cooled cell shroud).

Standard in-situ monitoring instruments, like RHEED, beam flux monitor, a quartz crystal microbalance, and a pyrometer can be mounted to the deposition chamber.

The EVO Compact can either be configured as a stand-alone system, with a load lock and buffer chamber or as part of a Materials Innovation Platform (MIP). With its compact footprint and its optimized design for 2D materials growth, the system is an ideal module for UHV cluster systems with the purpose of material screening and development. In combination with proven Scienta Omicron analysis modules, including an ARPES Lab or a Polar SPM Lab, the development of novel materials can be significantly accelerated.

The new EVO Compact offers the flexibility of a small deposition system and the capability to realise the full complement of MBE capabilities.

SCIENTA OMICRON'S LOCAL CHINA TEAM:
Strengthened by the Pandemic

Scienta Omicron China Sales & Service teams at the annual meet

The still ongoing pandemic has brought several challenges to our team in China. However, looking back, we now see that the unexpected situation has helped in creating a stronger and more independent team. A team that is better positioned than ever to support the growing customer base in China.

Our team in China consists of about 15 people active within mainly support and sales. Among them close to half have a PhD degree and all members have the sound industry experience needed to efficiently support our customers. Still, when the pandemic hit, they were challenged by a situation where they had to execute many new tasks. Strict quarantine measures meant that it was not possible for our support engineers to travel into China to support ongoing installations. Nor was it possible for members of our Chinese team to visit sites outside of China to get training.

The team has therefore had to execute full installations including acceptance testing, and also provide training to new team members as they have joined the growing team.

– I am genuinely impressed by the way that our local organization in China has been able to keep the service level on the same high level as before the pandemic, says Tobias Persson, Chief Revenue Officer, and also says:

(L) Dr. Zhipeng Sun on-site installation and (R) Zhichao Xu installing TRIBUS SPM Head

– Despite limited support from our European organization, they have successfully completed installations, given internal trainings and also been able to work out new solutions together with our customers in an amazing way. Being a country where research continues to be of increasing importance, we expect to see our China organization grow also in the years to come.

µARPES & ELECTRONIC ALIGNMENT

Stay Focused, Save Time

New material groups are often inhomogeneous consisting of small flakes or with domain structures on the µm scale. The same scale is relevant for microstructured devices. To extract meaningful high quality ARPES data from such samples requires high spatial resolution in the µm or even nm range (Figure 1). These small spot sizes introduce a new set of experimental challenges.

High quality µARPES data requires good control over the region of interest as well as an optimal alignment for ARPES measurement. The former is defined by the emission spot on the sample and the latter requires optimum alignment of the emission spot to the analyser for best deflection mode conditions. Without optimal alignment, measurement performance can be reduced (see Fig. 2 A and B).

To optimise this alignment, common setups must mechanically change both the sample position and photon source to move the emission spot to the optimal measurement position of the analyser.

Inevitably this causes the emission spot to move on the sample and away from the region of interest. Changing the measurement conditions (E_k, E_p, lens mode) alters the electron optical conditions and requires small readjustments of the alignment.

Using electronic adjustment of the analyser lens to replace the imprecise mechanical adjustment of sample and photon source, achieves best deflection mode measurement performance (see Fig. 2 C) while ensuring the emission spot remains in the actual region of interest.

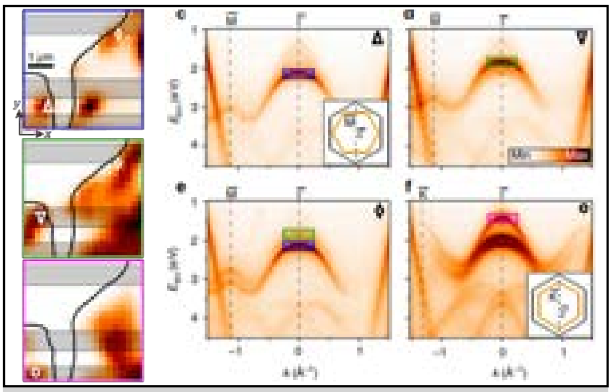


Figure 1: Local variations in the band structure of WS_2 on a variable number of graphene layers resolved with nanoARPES (DA30-L). Intensity maps (a - c) are reconstructed based on specific regions of the band structure near the Γ point, indicated by coloured squares in (d - e), and highlight the local variation of electronic properties. The band structures of representative regions in (d - e) are extracted from regions indicated by the symbols in the intensity map.
(Adapted from Ulstrup, S., Giusca, C.E., Miwa, J.A. et al. Nanoscale mapping of quasiparticle band alignment. Nat Commun 10, 3283 (2019). https://doi.org/10.1038/s41467-019-11253-2, http://creativecommons.org/licenses/by/4.0/)

The DFS30 introduces this groundbreaking electronic adjustment of the analyser lens to provide a significantly improved workflow, speed, and reproducibility when optimizing experimental conditions.

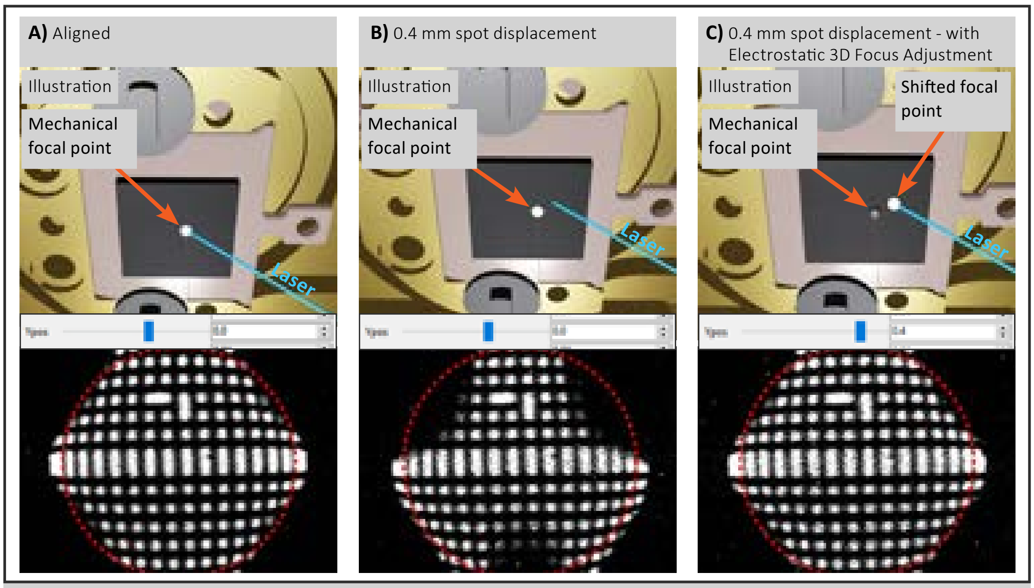


Figure 2: Electronic 3D Focus Adjustment results: A) shows a well-aligned situation with the analyser focal point and emission spot overlapping. The complete analyser acceptance angle, indicated by the red circle, is filled with accurate intensity. B) The 0.1 mm emission spot is misaligned by 0.4 mm. 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 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 analyser mechanical focal point, without Electrostatic 3D Focus Adjustment.

µARPES & Electronic Alignment advantages:

- Electronically shifts the analyser focal point in 3D to the emission spot
- Increases effective sample lifetime through fast and precise alignment

Note: You can upgrade your DA30-L with Electrostatic 3D focus adjustment.

SPRING-8 PEAK UPGRADE

PEAK API for Analyser Integration with Control Systems

The first HAXPES beamline BL09XU at SPring-8 synchrotron in Japan has successfully completed upgrading the analysers to PEAK acquisition control software. PEAK offers an application programming interface (PEAK API) which is designed for full analyser integration into external control systems. These integrated control systems simplify conducting a whole range of experiments that require controlling external parameters.

In 2021, BL09XU of SPring-8 was upgraded to a beamline dedicated for HAXPES experiments with a high-performance optical system providing a tuneable beam energy, high flux, narrow energy width (< 50 meV), high polarization degree, and high spatial resolution (1 µm spot size).

As the beamline optics, analyser, and sample manipulation are all controlled through a common system, advanced experiments such as mapping the microstructure of samples using micro-HAXPES are possible. For resonant HAXPES measurements to access element and orbital specific electronic states, the system automatically changes the conditions of many optical elements of the beamline. For each change in incident photon energy it is possible to acquire the corresponding spectra with the analyser (see Fig. 1).

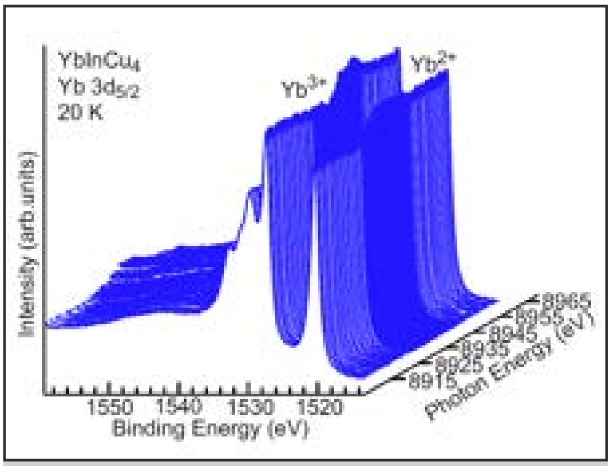


Figure 1: Resonant HAXPES spectra of Yb $3d_{5/2}$ around the Yb L_3 edge of $YbInCu_4$ measured at 20 K. (K. Maeda et al., Yb L_3 Resonant Hard X-Ray Photoemission Spectroscopy of Valence Transition Compound $YbInCu_4$, JPS Conf. Proc. 30, 011137 (2020), doi:10.7566/JPSCP.30.011137, CC BY 4.0)

Beamline Scientist Akira YASUI:
– The PEAK API and SDK helped in integrating the anlayser with our own control system (Python and LabView). Our control system takes care of the HV operation up to 12 kV, sample scanning, and synchronizes measurements enabling advanced and automatic HAXPES analysis for all users.

PEAK is based on a modular architecture to support the inclusion of new functionality and hardware (see Fig. 2). As the scale and complexity of a setup increases, distributed control systems (DCS) are typically used to establish a client-server model. The PEAK API is designed with DCS in mind and supports the client-server model with a modern network based communication interface.

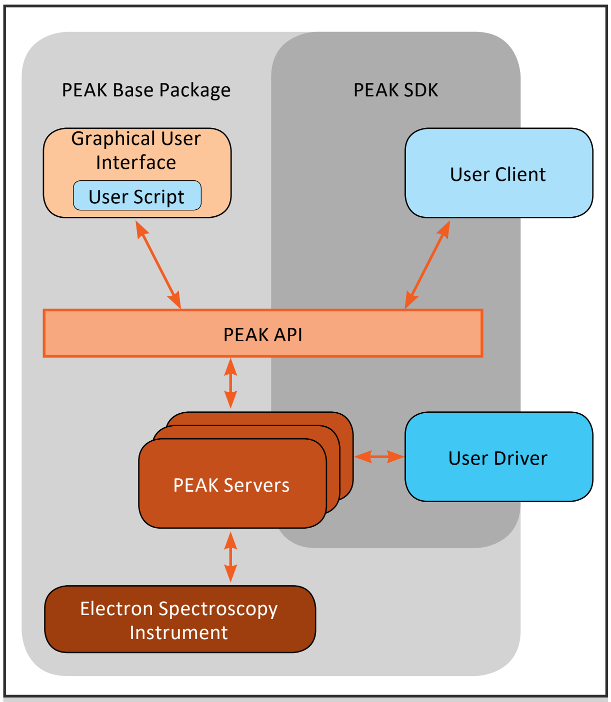
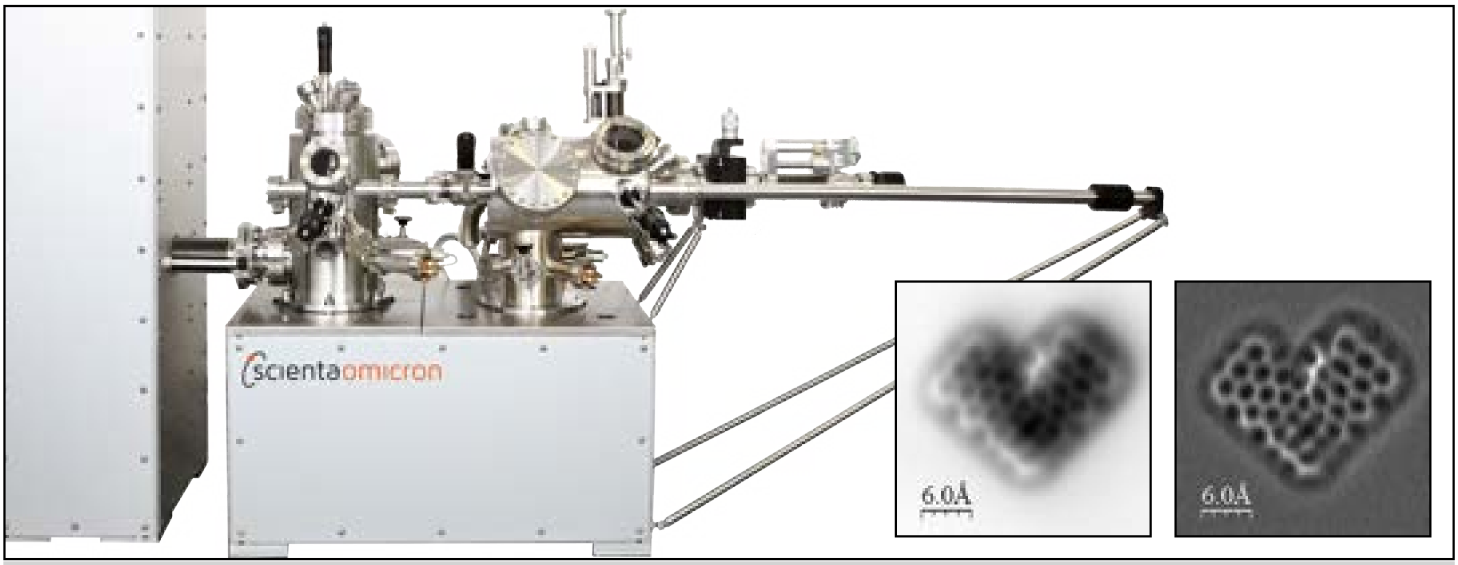


Figure 2: To integrate the analyser with a distributed control system a client-server model is established. The analyser functionality is equally exposed by the PEAK API to the user client as to the PEAK GUI (both are useable simultaneously).

The client can be implemented in a variety of languages such as TANGO, EPICS, Python or LabView. This allows the user to control the analyser acquisition from outside the instrument PC without requiring hardware driver routines. With this client server model it is even possible to run a DCS concurrent with the use of the PEAK GUI to monitor the live analyser settings and spectrum monitor. This can be especially helpful during development when verifying system performance.

INFINITY SPM

High Resolution qPlus® Imaging with CO Terminated Tip



Figures: left: INFINITY SPM system with preparation chamber; middle and right: raw image constant height frequency shift images of a porphyrinoid molecule on Au(111) and after background subtraction(right). Measurement parameters: reference setpoint: 150 pA, 5 mV, Z offset: +250 pm; Note that the observed molecule is not perfectly planar due to steric hindrances.
Data courtesy of Sylvain Clair, Christian Loppacher and Laurent Nony; Aix-Marseille Univ., Marseille, France.

The innovative low-temperature INFINITY SPM for high-resolution STM, qPlus® AFM, and spectroscopy experiments employs a pulse tube cooler to cool the instrument to temperatures below 10 K. Handling of liquid helium or liquid nitrogen is eliminated, making continuous operation of the instrument simpler and safer. To remove mechanical and acoustic noise, the closed-cycle, pulse tube cooler is housed in a separate high vacuum chamber. This unique two-chamber design of the INFINITY SPM is the key to high-resolution, long-term measurements (e.g. molecular qPlus® imaging, spectroscopy, dI/dV mapping…) with picometer stability.

Controlling the tip apex with atomic precision is crucial for maintaining the image quality in scanning probe microscopy. In particular, functionalisation with a single CO molecule allows to resolve the internal structure of adsorbed organic molecules in qPlus® mode [1]. In 2018, Q. Zhong, D. Ebeling, J. Tschakert, et al. demonstrated stable qPlus® imaging of 4,4″-diamino-p-terphenyl (DATP) with a CO terminated tip at temperatures between 5 K and 14 K [2]. With that result, Zhong, et al. confirmed that CO molecules are stably adsorbed at the tip apex and high resolution qPlus imaging with a CO terminated tip would be possible with the high-stability INFINITY SPM.
The team from the Aix-Marseille University is the first to demonstrate such qPlus® molecular resolution in the INFINITY SPM, thereby highlighting the tremendous potential of this closed-cycle SPM.

The porphyrinoid molecule adsorbed on Au(111) was imaged with a CO terminated tip in constant height mode. The clearly resolved internal carbon skeleton of the molecule is depicted in the figure, above. CO molecules were adsorbed on the surface by introducing a pressure of 1×10^{-8} mbar of CO to the UHV chamber and opening the radiation shield for 10 s.

The pickup of a single CO molecule by the metal tip was then obtained following standard procedures. [3]

With the growing number of INFINITY systems being installed around the world, we look forward to many future publications using this powerful qPlus® imaging technique.

References:
1. Gross, L. and Meyer G. et al.: The Chemical Structure of a Molecule Resolved by Atomic Force Microscopy, SCIENCE 325 Issue 5944 (2009) 1110-1114, DOI: 10.1126/science.1176210
2. Zhong, Q., Ebeling, D., Tschakert, J. et al.: Symmetry breakdown of 4,4″-diamino-p-terphenyl on a Cu(111) surface by lattice mismatch., Nat Commun 9, 3277 (2018). https://doi.org/10.1038/s41467-018-05719-y
3. Bartels, L.; Meyer, G.; Rieder, K. H. Controlled vertical manipulation of single CO molecules with the scanning tunneling microscope: A route to chemical contrast. Appl. Phys. Lett. 1997, 71, 213-215

CONFERENCE PARTICIPATION

American Physical Society (APS) March Meeting 2022

After a two year break, caused by the Corona pandemic, APS finally opened its doors to participants last month. The Chicago based exhibition turned out to be surprisingly busy in spite of the still ongoing pandemic. Scienta Omicron had one of the larger booths in a good location of the hall.

Quantum and the use of artificial intelligence were two of the main themes this year – not just in the exhibition hall, but also in the papers and presentations given throughout the week. It was evident that participants were enthusiastic about being able to meet in person again.

Scienta Omicron´s Sales Manager Bill Gerace and Sales Expert David Laken interacting with customers at the APS March Meeting 2022

SCIENTA OMICRON CUSTOMER WEBINAR

The Latest Developments Within UHV Materials Innovation


Scienta Omicron Materials Innovation Platform (MIP)

Since most conferences have been cancelled and some have been turned into virtual-only events, Scienta Omicron arranged a customer webinar on March 9^{th}. During the one-hour session we shared the latest developments within materials innovation, results achieved on our systems as well as new products being released. The main theme of the webinar was the broad portfolio of UHV solutions that we offer to support our customers drive their materials innovation.

Considering the broad attendance and the fact that virtual events have become a common way of interacting, we are likely to provide similar updates in the years to come.