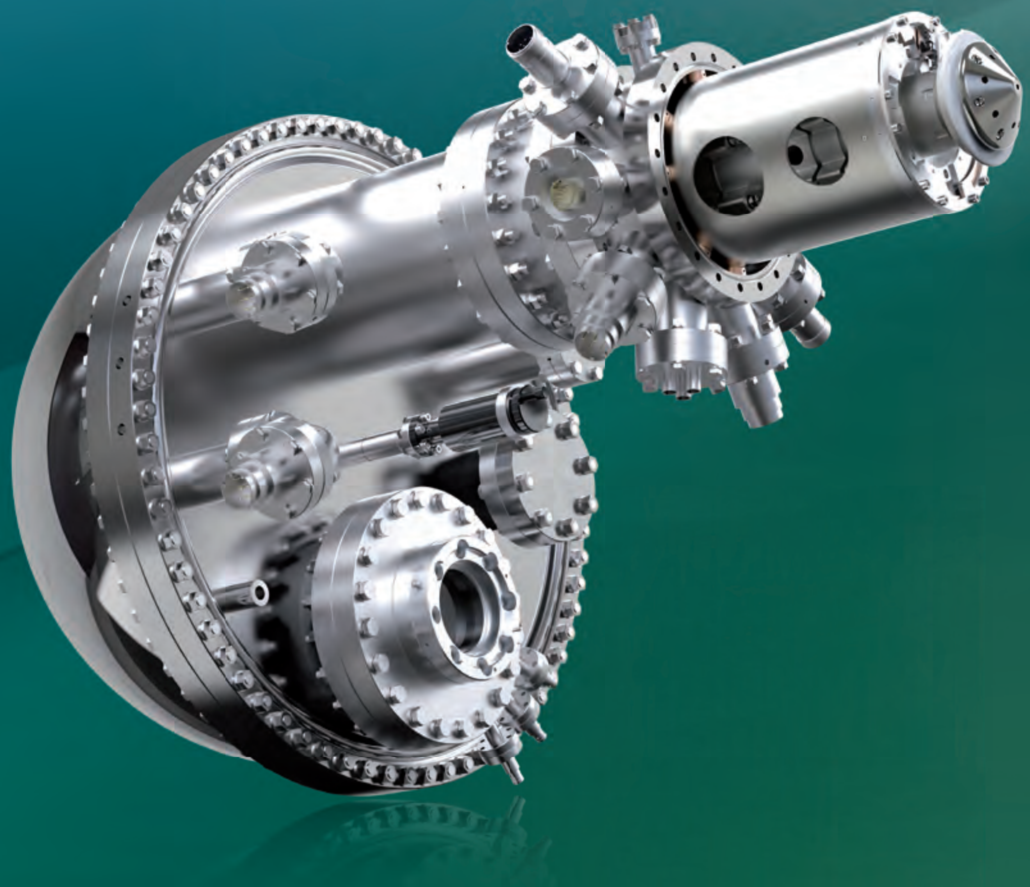
KREIOS 150

NEXT GENERATION ELECTRON ANALYZER
FOR SMALL SPOT ARPES AND MOMENTUM MICROSCOPY

KEY FEATURES

- Full 180° angle ARPES
- µARPES (< 2 µm field of view)
- Extractor zoom lens design
- Kinetic energy range 0-1500 eV
- Energy resolution < 15 meV
- Angle resolution < 0.1°



SPECS™

SPECS™

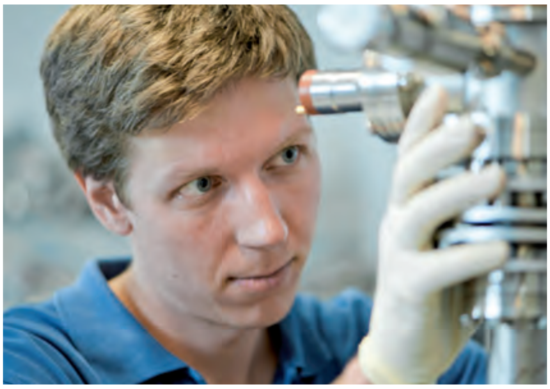
INNOVATION IN SURFACE SPECTROSCOPY
AND MICROSCOPY SYSTEMS

SPECS leads the way in developing cutting-edge components and systems for groundbreaking new surface analysis tools.

SPECS Surface Nano Analysis GmbH

SPECS Surface Nano Analysis GmbH headquarters is situated in the center of Germany's capital Berlin with subsidiaries in Switzerland, USA and China. SPECS has attracted a talented team of scientists and engineers who have dedicated their knowledge and experience to the development, design, and production of instruments for surface science, materials research, and nanotechnology for almost 30 years.

Mounting of component for final testing



SPECS engineer during system assembly

In order to continuously improve performance and keep abreast of the latest developments, we are in contact with numerous scientists, users and customers from all over the world. Reliable quality control (ISO 9001 certified) and excellent fast service, both remote and on-site, ensures maximum uptime and long-term operation and reliability of SPECS instruments over many years.

KREIOS 150

ELECTRON MOMENTUM SPECTROSCOPY
AND MICROSCOPY

SPECS leads the way to next generation intrumentation for materials research

Understanding the electronic structure of solid materials

Photoelectron spectroscopy is one of the most powerful and most frequently used spectroscopic technique in solid state physics, physical chemistry and materials science. Using the photoelectric effect, discovered by Hertz in 1885 and later described by Einstein, PES provides a material sensitive and non-destructive probe for modern scientists to examine the electronic structure of matter. By illuminating a sample with light of a certain frequency (photon energy), electrons are released from a solid, using the photons energy to overcome their binding energy in the solid. The remaining energy provided by the photons is transferred into the kinetic energy of the photoelectrons, which can be analyzed in an electron spectrometer. On this basis, a spectrum over the electrons binding energy in the material can be obtained.

Angular resolved photoemission spectroscopy (ARPES) is a technique to access the electron band structure of matter. In such an experiment the emission angle of an electron is here determined by the in plane momentum of the electron within the surface. Information about the electronic structure is important in novel materials in semiconductor industry and advanced basic research.

Current analyzers, hemispherical analyzers as well as time-of-flight spectrometers, can only access a limited area of the photoemission sphere, as the lens entrance only passively collects electrons from a relatively small solid angle. Increasing the acceptance angle can be done in two ways: reducing the working distance and increasing the opening of the lens cone. However, both methods have a negative influence on the accuracy of the performance of the spectrometer, as larger angles are more difficult to process in the classical lens system.

Combining ARPES and Momentum Microscopy

SPECS has recently started a new series of spectrometers, using a novel lens system in corporation with Surface Concept and the University of Mainz. For time-of-flight setups this spectrometer is called METIS and uses a k-microscope column as lens in combination with a drift tube and a time-resolving detector. The extractor lens applies a high voltage between sample and lens, which collects photoelectrons with up to ± 90° emission angle.

With this lens the barrier of passive electron collection can be overcome and allows analyzing the complete electronic structure.

This new lens system also provides a high lateral resolution in real space. A selection of and data collection from small surface areas is possible, opening the field of μARPES, so far only possible on synchrotron beamlines with special photon optics.

SPECS METIS 1000 is, hence, among the frontier and next generation ARPES analysis systems on the market for the ultimate angular resolved experiment. However, the ToF nature of this spectrometer requires the use of a pulsed light source, such as laser systems or Synchrotron light sources, often in special operation modes.

The new SPECS KREIOS 150 analyzer uses the same extractor lens, in combination with a hemispherical analyzer to use the ultimate angular information together with an electron analyzer for CW light sources, making this technique available for every light source, including laboratory light sources.

KREIOS 150 2D-CCD

METIS/KREIOS lens with extractor cone

SPECS KREIOS 150

ELECTRON MOMENTUM SPECTROSCOPY
AND MICROSCOPY

Combining ARPES and Momentum Microscopy

The new KREIOS 150

Laboratory solutions for ARPES need to be flexible and reliable. Classical (passive) hemispherical analyzers for PES are a well established and well understood technology. The logical next step is to combine a hemispherical analyzer with the new PEEM lens approach. The result is the SPECS KREIOS 150. Independent from the used light source it accesses the full photo electron emission-hemisphere (±90°).

The core of the lens is the patented extractor lens, with high HV stability and optimized performance for electron momentum spectroscopy and microscopy. The lens system produces reciprocal and real space images inside and at the exit of the lens. Apertures in the corresponding back-focal and Gaussian planes allow for selective spectroscopy (µARPES) or true photoelectron emission microscopy mode.

A hemispherical analyzer needs an entrance to select the k-vectors for energy dispersion. As a result, the second dimension in the reciprocal space needs to be scanned in order to obtain a 3D data set. The lens includes scanning options to map the k-vector of the emitted photoelectrons in the second k-direction.

Real space images will be obtained by a similar mechanism inside the PEEM lens, scanning the lateral resolved 1D profile along a second dimension above the entrance slit.

The analyzer comes with a highly precise power supply HSA 3500plus. As detectors either a 2D-CCD or a 2D-DLD detector can be chosen. For spin-resolved measurements a direct imaging spin detector (DiSpin) is available.

2D-CCD detetctor

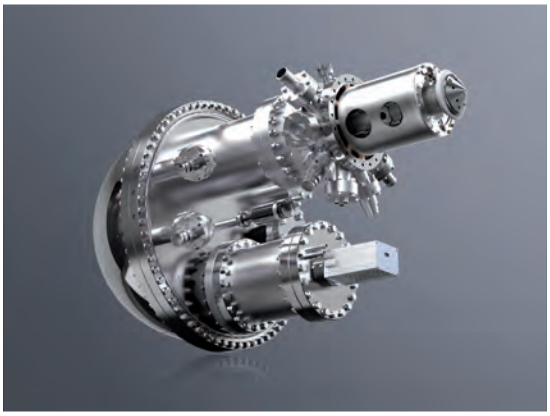
2D-DLD detector

HSA 3500plus power supply (left)

KREIOS 150 MM - Momentum Microscopy

KREIOS 150 MM 2D-DLD

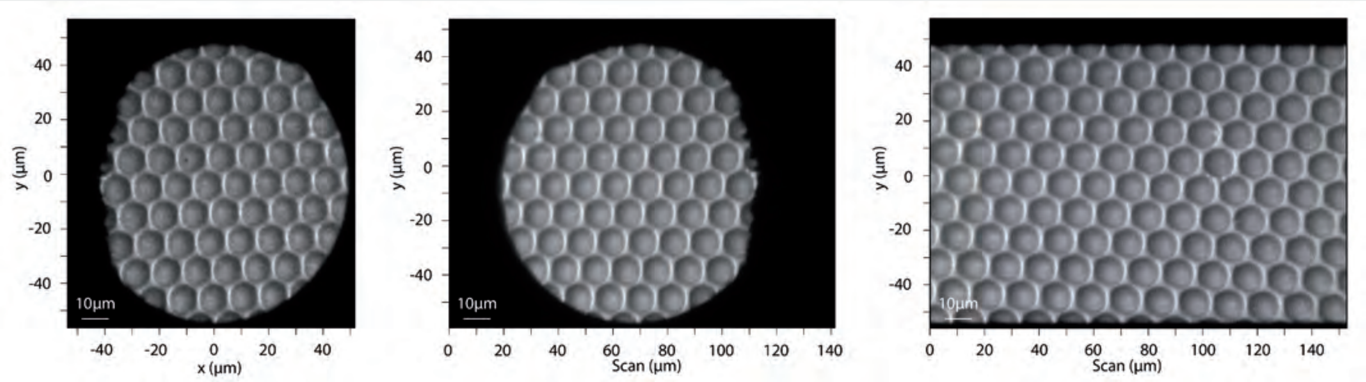
The PEEM lens functionality allows for a second configuration of the KREIOS: the Momentum Microscopy version KREIOS 150 MM. Here, the k_x/k_y image is energy filtered as a 2D image by the hemisphere, neglecting the energy dispersion in favor for an immediate k-space image on the detector. For this a special lens in front of the 2D detector is needed. The energy dimension can be obtained by scanning the energy with the hemisphere, ending up with the same 3D dataset as in the standard version, however, optimized for k-microscopy solutions.



PEEM Operation

The PEEM operation is shown on a test sample (channel-plate, energy integrated). Each channel-plate hole has a diameter of 10µm. Using the KREIOS, PEEM images can be obtained by using the integrated scan functionality.

Two different operation modes are possible, using magnetic and electrostatic scanning, within different setting inside the lens. The scanning functionality is independent of the acquisition mode, e.g. usable for ARPES measurements.



PEEM image of a channel-plate test sample (left). Similar PEEM image obtained using magnetic scanning (center) and electrostatic scanning (right) in KREIOS.

Technical Data

Specifications

KREIOS 150	Value
Utimate Angular Accep-tance	±90°
μ-ARPES acceptance area	down to 2 μm
Angular Resolution	< 0.1°/0.1k-1
Energy Resolution	< 15 meV
Kinetic Energy Range	0-1500 eV
Pass Energy	0-666 eV
Mean Radius	150 mm
Mounting Flange	DN 150 CF
Working Distance	4-10 mm
Lens	angular and spatial resolved
Detectors	2D-CCD, 2D-DLD, 2D-CCD/3D Spin, DISpin

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