UV Source Series

UV SOURCES FOR ULTIMATE INTENSITY AND STABILITY

KEY FEATURES

- Spectroscopic VUV light sources
- Variable excitation lines
- Small spot focussing optics (optional)
- Polarizer (optional)
- UV monochromator (optional)
- Automated operation

SPECS™

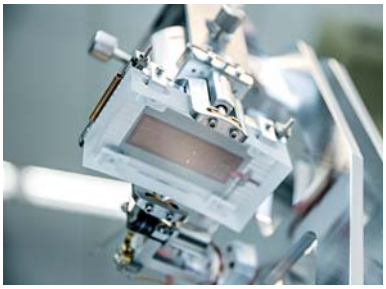
A member of SPECSGROUP

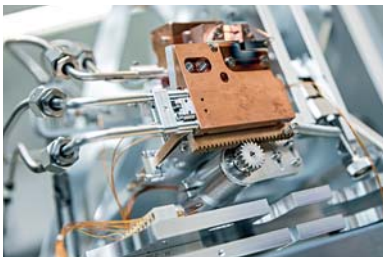
SPECS™

Innovation in Surface Spectroscopy
and Microscopy Systems

Innovative components and systems for groundbreaking new surface analysis tools – that's SPECS.

Our headquarter 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. In order to continuously improve performance and to make available 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.

UV Source Series

ULTIMATE PERFORMANCE AND RELIABILITY

Characterization of the electronic structure of new materials by valence state spectroscopy

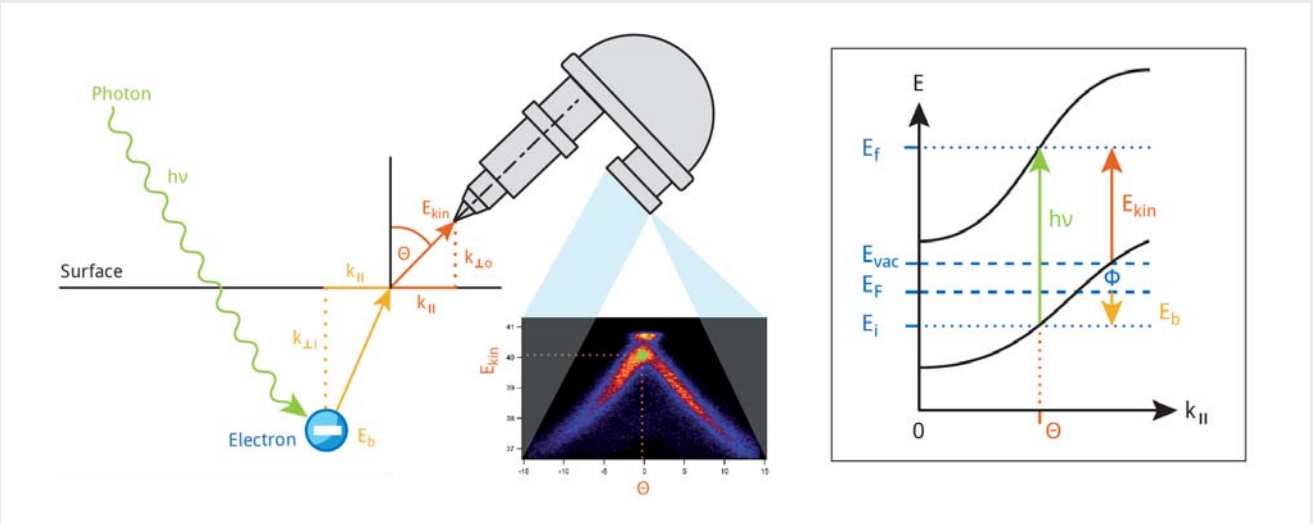
Ultraviolet and Angle Resolved Photoelectron Spectroscopy (UPS, ARPES)

Photoelectron spectroscopy (PES) is one of the most powerful and most frequently used spectroscopic techniques in solid state physics, physical chemistry and materials science. Using the photoelectric effect, PES provides a material sensitive and non-destructive probe for modern scientists to examine the chemical composition (XPS or ESCA) and the electronic structure (UPS and ARPES) of matter.

By illuminating a sample with light of a certain photon energy (hν), electrons are released from a solid, using the photon energy to overcome their binding energy (E_b) and work function (Φ). The remaining energy provided by the photons is transferred into the kinetic energy (E_{kin}) of the photoelectrons. The surface breaks the geometry, affecting the momentum conservation such, that only the parallel wave component k_{II} is conserved after crossing the surface.

Finally the electrons can be analyzed in an electron analyzer with respect to their E_{kin} (or E_b) and to Θ representing k_{II}. On this basis, a 2D distribution of the electrons for given E_b and k_{II} is measured, directly reflecting the electronic band structure of the material. Such experiments in laboratory environments require intense, small spot UV light sources of high stability for optimum performance.

SPECS offers a series of small spot UV sources fitted to various demands, starting from flexible and robust UV sources for economic application to highly sophisticated UV sources for different gases and photon energies with monochromators for highest performance and energy resolution.



Angle resolved photoelectron spectroscopy

UVS 10/35

UV Discharge Lamp

For ultraviolet photoelectron spectroscopy on solids (UPS), the high performance ultraviolet source UVS 10/35 is ideally suited. The design of the discharge chamber results in high intensity and it also facilitates easy ignition and extremely stable operation of the discharge.
The UVS 10/35 can be mounted on any DN35CF flange on an analysis chamber as the flange-to-sample distance is not critical. Efficient differential pumping ensures a long operating life. The He I or He II ratio can be controlled by adjusting the pressure of the gas in the discharge chamber. Typically the source is operated using He gas in He I and He II mode. Other gases (Ne, Ar, Kr, Xe) can also be used for operation.

Power Supply

The COSCON UVS supplies all voltages and currents needed for the SPECS UVS 10/35 source operation. The new concept allows full computer control of the source via Specslab Prodigy on the integrated web interface. The power supply operates in constant voltage or constant current mode. Before ignition the power supply operates in voltage mode. It also ensures fail safe operation of the UV-source. An interlock circuit turns off the high voltage applied to the source to prevent UV-source damage.
The computer control of the power supply supports extended measurement automization in combination with other SPECS equipment.

Polarizer and Accessories

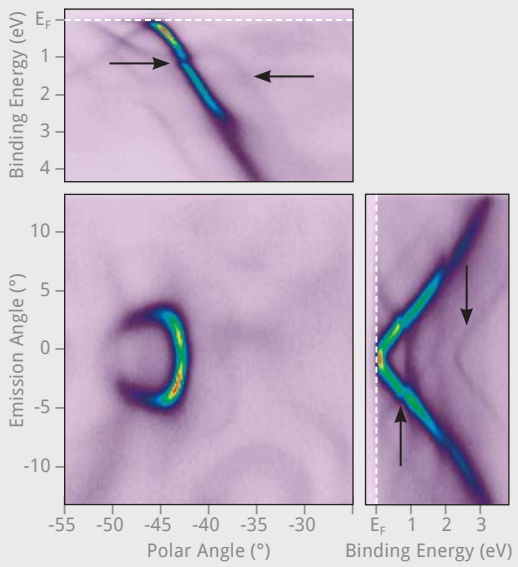
The UVS 10/35 can be equipped with a polarizer unit mounted to the end of the capillary to switch from non-polarized to linear polarized UV light and to change the polarisation direction.
A dedicated gas inlet system, as well as an efficient differential pumping package is available. An automated gas inlet is available.

Features

- Cold discharge
- High photon flux / discharge current ratio
- Excellent and adjustable He I / He II ratio
- Differential pumping
- Easy operation and ignition
- Stable output

UPS and ARPES

Graphene adsorbed on Ir(111) shows an interesting electronic structure. The dataset shows a 3D band map aquired with a PHOIBOS 150 2D CMOS. Due to a mismatch between the graphene layer and the substrates unit cell dimension, a super-lattice is formed. This super-lattice induces the formation of back-folded replica bands. When these replica bands cross the original graphene band, mini gaps are formed (see black arrows).

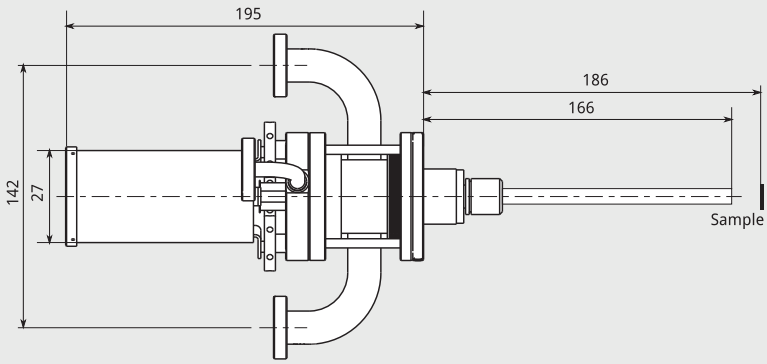


Band map of graphene/Ir(111) K point, acquired with He II excitation.

Technical Data

Specification	Value
Gases	He, Ne, Ar, Kr, Xe
Photon Flux Density	8×10^{15} photons/s*sr
Photon Current	15-40 nA
Beam Divergence	< ±1°
Capillaries	Quartz (0.8 and 1.3 mm)
Mounting Flange	DN35CF
Insertion Depth	166 mm
Bakeable	up to 250 °C

Dimensions



UVS 10/35

µSIRIUS

Duoplasmatron UV Source

A new generation of the SPECS UV source improves the performance of the well-established duo plasmatron light source UVS 300, keeping its unique features for small spot analysis for ARPES and UPS. Using an optimized design it is possible to control the plasma generation with much higher precision than before. As a result a brilliant and bright UV source has been designed, named after the brightest star in the sky, Sirius. The main item of the µSIRIUS is the newly designed and fully 3D printed discharge chamber. The water cooling is now imprinted in the discharge housing. That reduction of size allows us to increase the quality of the magnetic field on the duo-plasmatron discharge area.
The body is designed entirely for a full UHV operation of the source. Hence, the bake out capabilities and gas purity of the source are increased. A new type of filament on industry standard lifetime guarantees extreme long life performance of the source (> 5.000 hours). The new design has an optical viewport through the complete UV source, which allows aligning of the source with an external laser pointing device.

Unsurpassed small spot optics

The µFOCAL 100 focusing capillaries is designed for optimal performance with the new SPECS µSIRIUS. This new generation of optics aims at highest photon flux densities for unrivaled ARPES performance and highest count rates. The combination of a real point source, such as the µSIRIUS, yields maximum focusing of all emitted photons onto the sample without the need for artificial confinement of the emission spot. The smaller the focus gets, the higher the local photon flux density and hence the higher the performance of the new generation of SPECS small spot hemispherical analyzers.
The smaller the spot size, the higher the angular resolution achievable by electron analyzers. The ASTRAIOS 190 ARPES analyzer benefits from a maximum photon flux density within its acceptance area and from a significantly increased angular resolution. The KREIOS series analyzers benefit from the high photon flux desnity for µARPES applications as a higher flux density is available under the real space selection apertures. Hence, both imaging quality and aquisition time are strongly improved.

Features

- High photon flux density
- Optimal focusing to 100/300 µm
- Adjustable He I / He II ratio
- Long filament life time
- Fully UHV compatible
- All noble gases

ETC – Versatile Focusing Optics

The ETC capillary is a long time established standard, offering an excellent price to performance ratio. The elliptical design of the capillary allows a spot size down to 300 µm and a continously adjustable spot size. The spot size fits all SPECS analyzers for best performance in different fields of application. The ETC optics are compatible with vacuum housings for near ambient pressure application and for integration into the SPECS LEEM/PEEM P90.

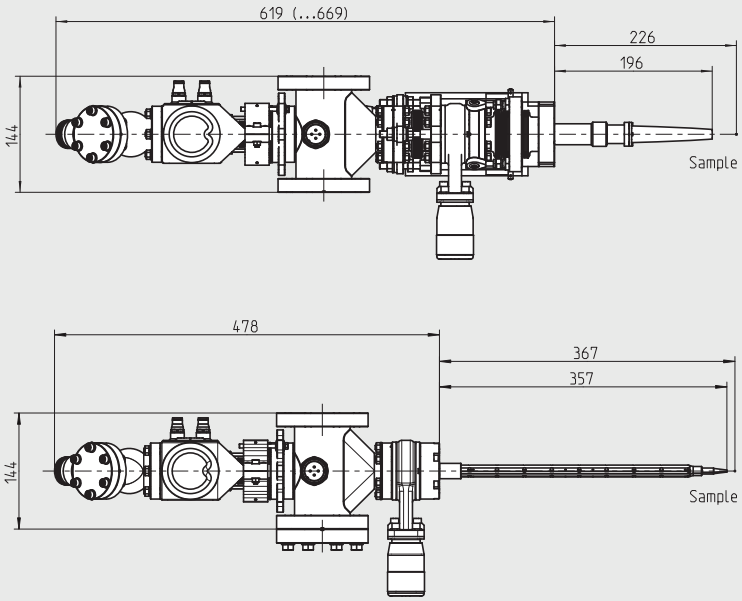
COSCON Power Supply

The source is controlled up by a new generation of power supplies, driving the source at higher power for outstanding performance. The SPECS COSCON series is a fully remote controllable power supply standard, now available for UV sources. It is controlled either via SpecsLab Prodigy or via its own web interface. A full integration into measurmenet automation is available for the COSCON SUVS. For stand-alone operation it is supplied with a compact and versatile touch screen for operation in front of the system.

Technical Data

Specification	µFOCAL 100	ETC
Gases	He I and He II, Ne, Ar, Kr, Xe possible	He I and He II, Ne, Ar, Kr, Xe possible
Photon Flux Density (He I)	> 1×10^{15} photons/s*mm²	> 1×10^{14} photons/s*mm²
Spot Size	100 µm	300 µm
Spot Shape	Gaussian	n/a
Mounting Flange	DN35CF	DN35CF
Insertion Depth	196 mm	357 mm
Operating Pressure in AC	< 5×10^{-8} mbar	< 5×10^{-8} mbar
Lifetime	> 5.000 h	> 5.000 h
Monochromator Version	yes	yes
Bakeable	150 °C	150 °C

Dimensions



Top: µSIRIUS Small Spot (µFOCAL); Bottom: µSIRIUS Focused (ETC); all in top view

TMM 304

Toroidal Mirror Monochromator

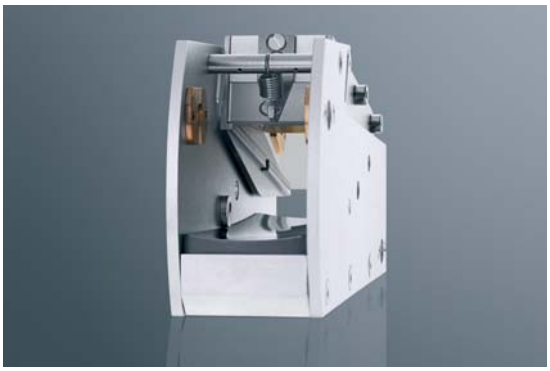
The TMM 304 is a toroidal mirror monochromator for laboratory UV sources, compatible with the µSIRIUS. It can be equipped with two cassettes which are optimised for specific wavelength. Switching the cassettes can be performed without braking the vacuum. The light is guided towards the sample by a focusing the new µFOCAL 100 or ETC capillary resulting in small spot sizes and high photon flux densities.
In combination with a high performance differential pumping system UPS measurements under excellent UHV conditions can be performed. It is optionally available with a rotary stage to change the polarization in-situ. The rigid frame is retractable for easy mounting and operation and offers ultimate stability and precision at the same time.

Cassettes

Cassettes consists of a matched grating/mirror pair. Each cassette is optimized for a particular wavelength. Cassettes are available for He I and He II, as well as for Xe (with 1.200 and 2.400 lines/mm). The degree of polarization is > 80 %. An optional polarizing cassette is also available with a resulting degree of polarizaten exceeding 90%.

Frame

The TMM 304 can be ordered with a fixed or rotatable frame. Both versions come with a z-retract, a rotation base and a tilt for easy beam alignement. The rotatable frame provides an additional motorized rotation around the beam axis to switch between s- and p-polarized light, without braking the vacuum.

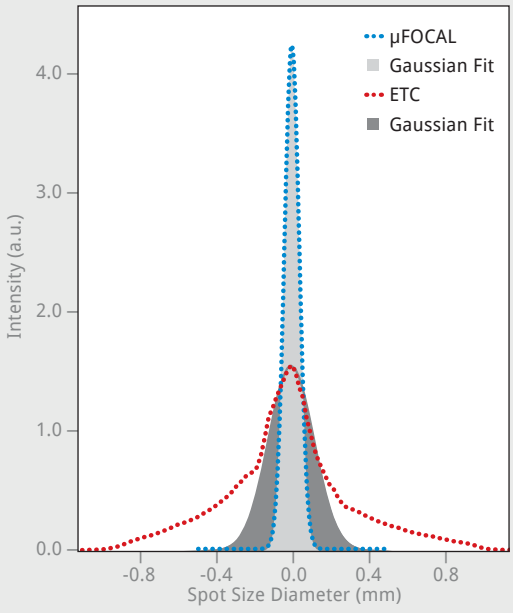


Features

- Two cassettes installed
- High photon flux
- Cassettes for He I, He II, Xe and polarizer
- Advanced differential pumping
- µFOCAL 100 or ETC for small spot size and high photon densities
- Rotatable frame for changing polarization of UV light

Spot Size

The new µFOCAL 100 optics yield spot sizes better than 100 µm. The spot size of a UV source is linked to the ARPES performance and its small spot capability. The µFOCAL 100 optics provides a spot size (FWHM) of < 100 µm and the ETC of < 300 µm when combined with the new µSIRIUS source. The plot below shows factory test measurements done on the different optics, for the µFOCAL 100 (blue) and ETC capillary (red). The measured beam profile is marked with the dotted line and the Gaussian fit of the main component is a solid line. The new µFOCAL 100 optics characterization demonstrates the almost perfect Gaussian peak shape, providing optimal conditions for high performance APRES analysis. The ETC capillary can reach a peak FWHM of < 300 µm. Allthrough based on a broad background, the main photo-emission intensity will come from a defined area in the center. Hence the SPECS small spot analyzers benefit from from the aligned spot size and field of view of 300 µm, respectively.

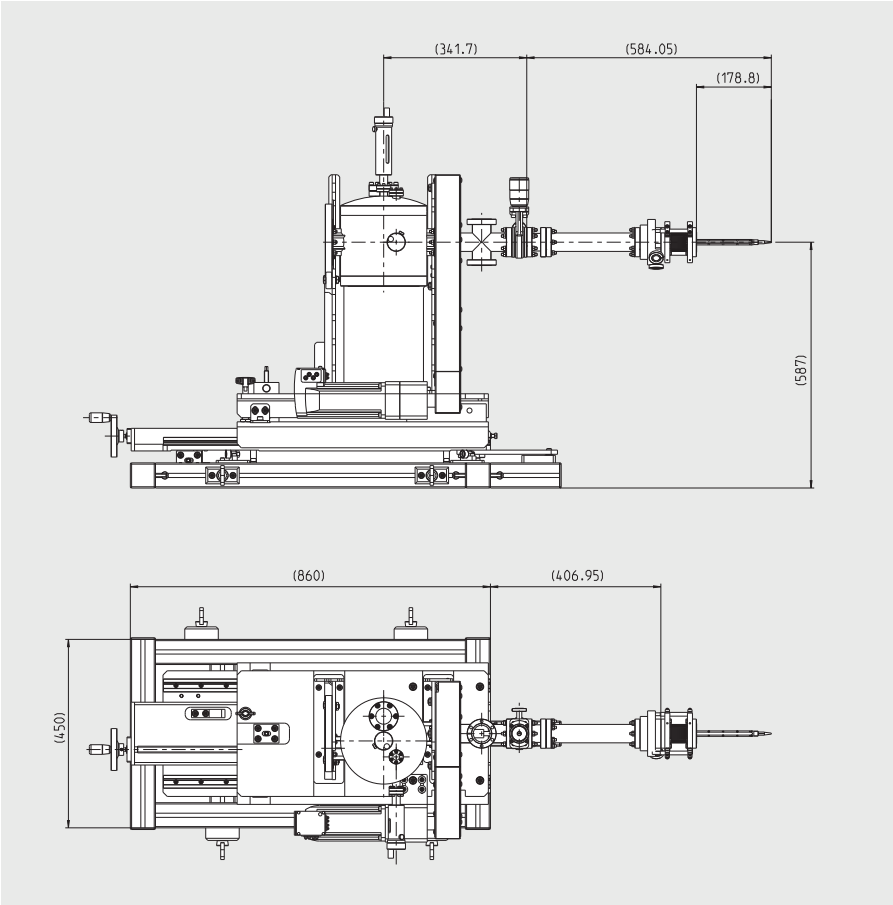


Spot sizes better than 100 µm.

Technical Data

Specification	µFOCAL 100	ETC
Line width	< 1 meV	< 1 meV
Photon Flux Density	> 1×10^{14} photons/s*mm²	> 1×10^{13} photons/s*mm²
Spot Size	100 µm	300 µm
Mounting Flange	DN35CF	DN35CF
Operating Pressure in AC	< 5×10^{-10} mbar	< 5×10^{-10} mbar
Bakeable	150 °C	150 °C
Rotatable Frame Available	yes	yes

Dimensions

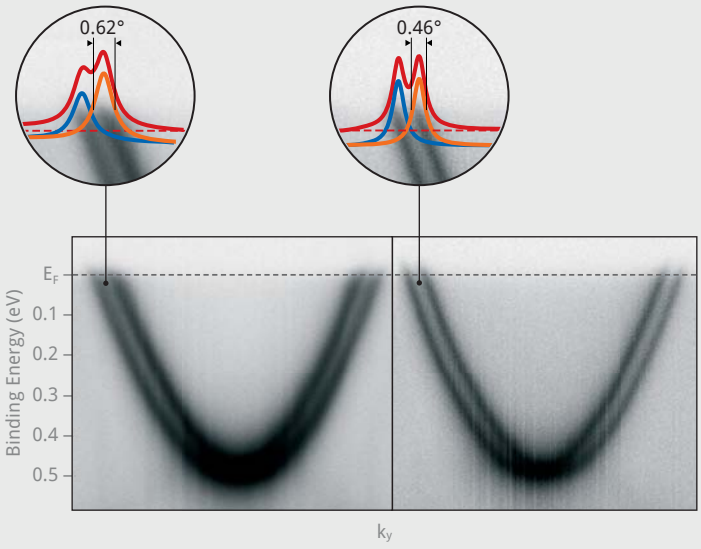


TMM 304 Monochromator

Application

ARPES

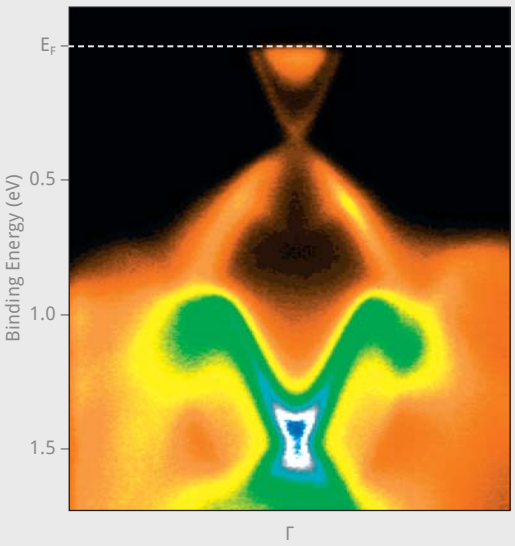
The smaller the spot size, the higher the angular resolution achievable by the analyzer. The below shown application shows the Au(111) surface state, acquired subsequently on the same sample with the same PHOIBOS 150 2D-CMOS analyzer. The left panel show the µSIRIUS predecessor UVS 300 with ETC optics (500 µm spot), the right panel shows the same dataset acquired with the µSIRIUS µFOCAL 100 (100 µm spot). The angular broadening of the Au(111) Rashba splitting depends directly on the spot size of the source on the. Going from 500 µm to 100 µm lowers the FWHM from 0.62° to 0.46°, showing a significant performance boost.



Band Map of Au(111) surface state. Left: UVS 300 with ETC Optics. Right: µSIRIUS with µFOCAL 100.

Topological Insulators

Topological insulators are insulating materials with surface states crossing the gap between the (bulk) valence and conduction band. Bi_2Te_3 is a well known example for this kind of materials. The image shows an energy disposal image of the thus described surface state at the Γ point of the Brillouin zone. Its two branches have different spin states, avoiding the opening of a band gap at the touching point of these two bands. The result is a dirac cone like structure. This reference measurement has been aquired on an PHOIBOS 225 2D-CCD at 70 K sample temperature during a factory acceptance test.



Γ point of Bi_2Te_3, raw data from PHOIBOS 225 2D-CCD with UVLS and TMM 304 at T=70K.

Observing Quasiparticles

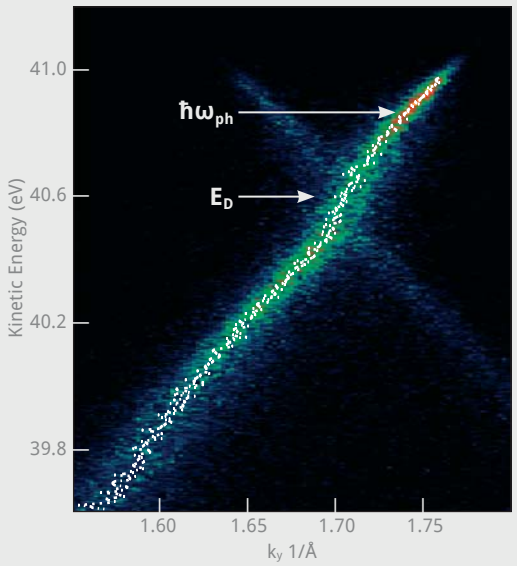
In 2007, Bostwick et al. reported the observation of a plasmaron dispersion, the interaction of the electron with the plasmon wave of a solid, in graphene on SiC. Close to the Fermi level, a kink in the band dispersion is visible, attributed to the electron/plasmon interaction.

Using the ASTRAIOS 190 in combination with the TMM 304 and µFOCAL 100, this result could be reproduced at room temperature using the 100 µm spot size. The band dispersion image is an extraction from a 3D scan acquired within 30 minutes in a ± 10° angular resolved mode. The fit indicates the band intensity maximum.

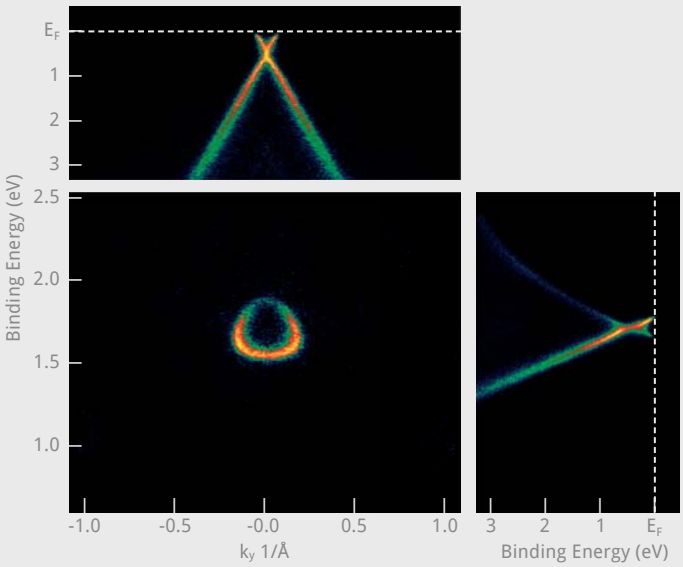
Small Spot Band Mapping

The band map of the graphene on SiC K-point has been acquired with an ASTRAIOS 190 2D-CMOS at room temperature within 15 minutes. The angular acceptance angle had been set to ± 20°. The plot shows excerpts from a 3D dataset of I (Ekin, kx, ky). The central image ist a constant energy cut, showing kx vs. ky. The side graphs are cuts of Ekin vs. kx and ky respectively across the Ekin, kx, ky – reciprocal space.

The high photon flux density and the small spot size perfectly fits the ASTRAIOS analyzer field of view for maximum intensity and short acquisition times.



Band Dispersion of Graphene on SiC. Close to EF a kink ($\hbar\omega_{ph}$) is visible, which us attributed to the plasmaron quasiparticle.



Band Map of Graphene/SiC K-Point, acquired at Room Temperature with the µFOCAL 100 optics and a TMM 304. Acquisition time 15 minutes.

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