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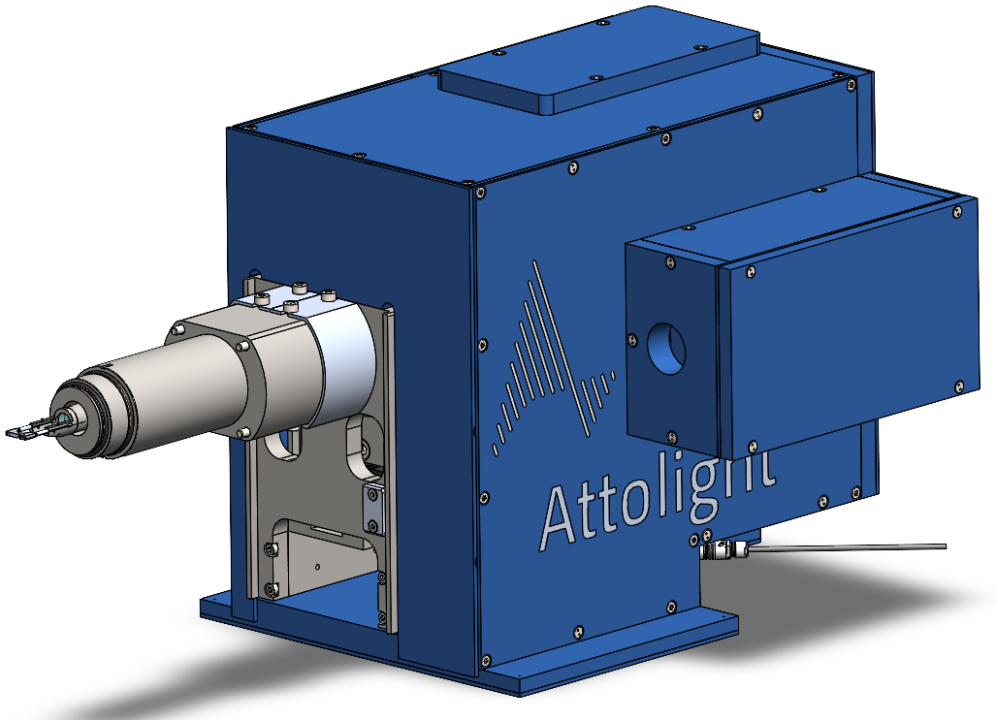
MÖNCH

Light collection and injection add-on for (S)TEMs

Cathodoluminescence - Photoluminescence - Gain spectroscopy - Local thermal excitation



Benefit from a versatile system that includes both light collection and injection modes.

Reveal unprecedent features of your sample: composition, structure and defects.

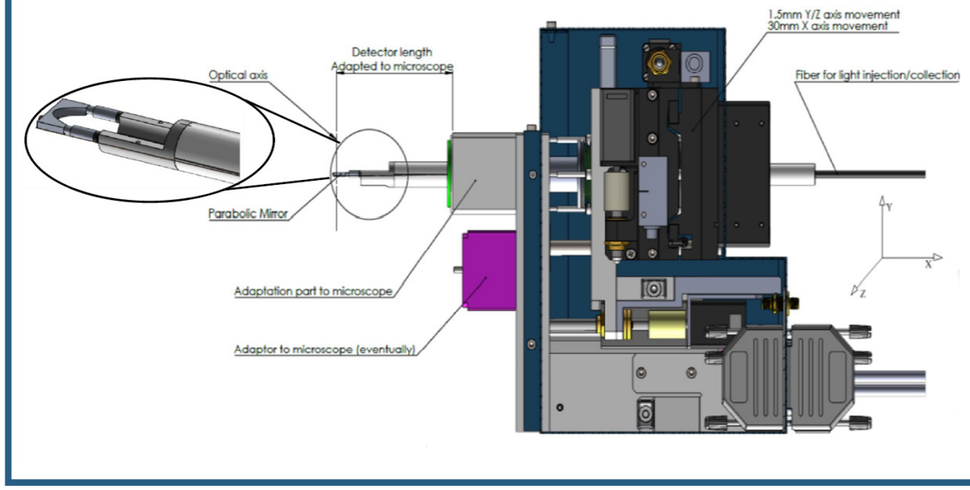
Take advantage from a fully optimized system with large collection angle.

Excite samples to reveal local behaviour under light/thermal excitation.

The Mönch is an easy to use and accurate add-on for light collection or injection in (S)TEM thanks to:

- A **mirror independent from the sample holder** allowing for a perfect and optimized alignment ;
- An absolute encoding system ensuring **high alignment precision and reproducibility** (100nm-precision) ;
- The ability to **inject and/or collect light** either in **free space or via an optical fiber**.

System overview



Light collection mode:

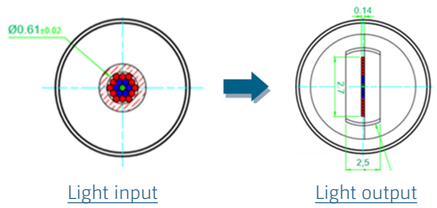
The Mönch has been designed and carefully optimized to achieve unprecedent signal-to-noise ratio thanks to:
- A **proprietary parabolic collection mirror** designed to fit into pole piece gap ;
- A **positioning system** with sub-micrometer precision for perfect alignment of the mirror with respect to the sample;
- A **high curvature parabolic mirror** with a NA > 0.4;
- A **working distance reduced to 300µm** to maximize the light collection/injection efficiency;
- A **patented asymmetric optical fiber** designed to preserve brightness and spectral resolution.

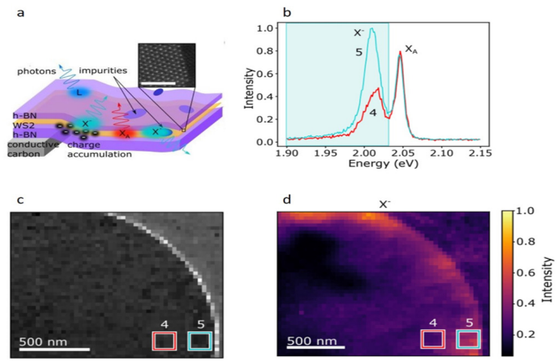
Light injection mode:

The Mönch reaches unprecedent level of performances and versatility thanks to:
- A **beam size reduced to few microns** for localized light or thermal excitation of samples;
- The ability to perform **injection and light collection measurements simultaneously.**

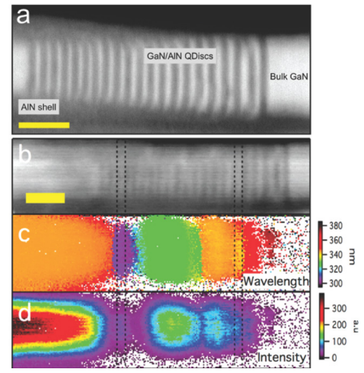
Patented optical fiber:

The Mönch uses of an asymetric optical fiber with a bundle rearrangement from round to parallel to the entrance slit of the imaging spectrograph. This enables keeping constant spectral resolution even when the slit is opened and the spot moving at the entrance of the slit due to scanning.





a) h-BN/WS2/h-BN heterostructure shows three emission lines: excitons (XA), trions (X-) and localized emitters (L). b) CL spectra for the regions highlighted in c and d. c) HAADF region measured in d and d) the X- intensity map revealing local trion enhancement.
(Bonnet et al., avarXiv:2102.06140 (2021)).



Spectral imaging of a GaN/AlN NW with 20 QDisks (a) HAADF image of a GaN/AlN nanowire Scale bar is 20 nm. (b) HAADF of the NW, acquired simultaneously with the CL. (c) Wavelength position of the most intense peak. (d) Intensity of the most intense peak.
(L.Zagonel et al., Nano letters, 11(2), 568-573 (2011)

Light collection/injection modes

Mode	Excitation source	Analysis (detection)
Light collection Sample under vacuum → Outside	E-beam, Laser, Thermal, Electrical…	Cathodoluminence (light)
Light injection Outside → Sample under vacuum	Laser …	Electron imaging (electron) in photoemission/thermoionic regimes
Light injection + collection Outside ⇆ Sample under vacuum	Laser…	Photoluminesence (light)

Topics:

- Electronics & Optoelectronics (GaN, InP, SiC…)
- Photovoltaic cells (GaAs, CdTe, Perovskites…)
- Light emitting diodes (LEDs)
- 2D materials (Graphene, BN, WS2, diamond…)
- Noble metals (plasmonic)
- Photonic crystals
- Quantum wells & quantum dots
- Minerals, glasses, ceramics and gemstones)
- Inorganic coatings
- Organic, polymer samples

Mönch: Unique Light collection/injection add-on for STEM

High spectral resolution • High collection efficiency • Fits into small pole-piece gap
Versatile and flexible system • Mirror independant from the sample • Sub-micrometer alignment of mirror
No need for sample pre-aligment • CL analysis of whole sample area • High field of view • No vignetting
Large choice of detectors • Fast hyperspectral map measurement time• Unprecedent signal-to-noise ratio
No compromise between brighness and spectral resolution • Compatible with other techniques (EELS, EDS…)

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Mönch Features

Specifications

Mirror:
- High numercial aperture parabolic mirror (NA>0.4)
- Mirror reflectivity: >70% from 200nm to 1.7µm
- Compatibility for light collection and injection modes

Light collection mode
- Optical fiber with adapted insertion slot
- Collection light vawelengths range: 200-1700nm

Light Injection mode
- Free space to avoid loss of spatial coherence and degradation of signal power density
- Injection light wavelengths range: 350-1100 nm
- Laser spot size on specimen: down to 5µm-FWHM@532nm, *Switching possible between both modes*

Detectors
- High speed UV-Visible EM-CCD or CCD camera (200 nm–1100 nm)
- InGaAs near Infra-Red detector (900 nm–1700 nm)
- Panchromatic detection (PMT; 200 nm–900 nm)

Micro-positionning system:
- Travel range: 30mm (X), +/-1mm (Y), +/-1mm (Z)
- Retractable mirror with position reproducibility <1µm
- Absolute encoders
- Collison detection
- X-Rays Protection (300keV-compatible)

Dispersive spectrometer
- 328 mm focal length
- Up to 4 turrets

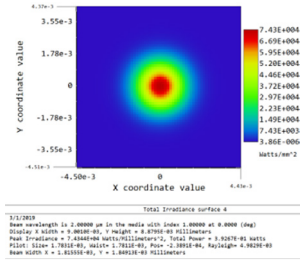
System control:
- External scanning card
- Resolution: from 128x128 to 2048x2048
- Dwell times: from 1µs to 5ms
- Field of view: consistent with TEM internal scan system

Software:
- Arm/mirror control software
- Acquisition/visualisation software

Light injection : Beam size simulation

The specific mirror shape enables generating a micrometer beam spot size on the sample surface.
For a input laser beam diameter of 0.5mm, the beam spot size on the sample surface is approx. 5.0µm-FHWM.

Optical simulation:



STEM compatibility:

- Compatible with most of the (S)TEM models : TFS, JEOL, Nion, VG...
- One available port in the PPG plane
- Contact us at : contact@attolight.com to check the compatibility of your (S)TEM models

About Attolight AG:

Attolight AG started off to revolutionise cathodoluminescence (CL) by designing top of the line CL instruments that deliver superior performance, maximum ease-of-use and makequantitative cathodoluminescence. The Company firmly believes in the potential of cathodoluminescence and aims at establishing the technology as a standard in-line inspection method in semiconductor industry.

Attolight AG is a company with global presence with systems in Europe, Asia, and North America. The Company headquartered is located in Ecublens close to Lausanne-Switzerland.

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