

Attolight CL / Discover Quantitative Cathodoluminescence at High Space and Time Resolution



Overview

The **Attolight CL** system is the first quantitative cathodoluminescence system offering a spatial resolution below 10 nm, a field of view of 300 μm , and an optional 10 ps time resolution mode.

Attolight CL combines a proprietary scanning electron microscope (SEM) with an integrated light microscope. The light microscope is embedded within the electron objective lens of the SEM so that their field of view match each other. Acquiring cathodoluminescence (CL) maps has never been easier: no optical alignment is required and the specimen is positioned thanks to the light microscope. The system is optimized to achieve superior CL performance without compromising the SEM performance. It offers an outstanding optical aperture (f/0.5), a constant and superior photon collection efficiency over the whole field of view, and a low electron beam energy range (3–10 kV) for enhanced resolution of CL maps.

Attolight CL is the only system on the market that enables quantitative benchmarking of cathodoluminescence emission from one specimen to the other. Its unique ability to reveal ultra-trace impurities and crystallographic defects not visible using other imaging modes opens new possibilities for research and development of semiconductor materials, phosphor, ceramic, rock and glass.

A 6-degrees-of-freedom displacement system insures arbitrary positioning of your specimen with 1 nm increments. For advanced applications requiring a deep understanding of the fundamental properties of a material or high cathodoluminescence emission efficiency, an optional cryogenic nanopositioning stage can be installed. It features temperature control between 20 K and 300 K and includes a patented mechanical design to minimize drifts and vibrations.

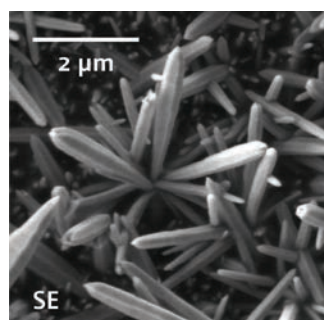
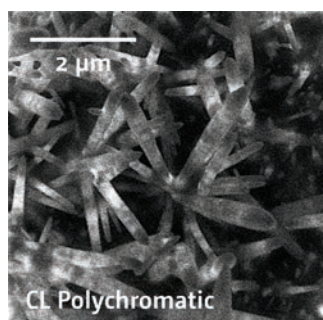
Attolight CL is also the first cathodoluminescence microscope featuring an optional time-resolved detector with an unmatched 10 picoseconds time resolution. Time-resolved cathodoluminescence is the perfect technology for charge carrier dynamics and lifetime measurements in opto-electronic materials.

Key Benefits

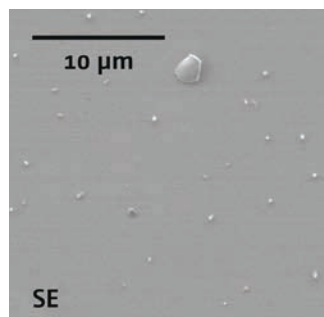
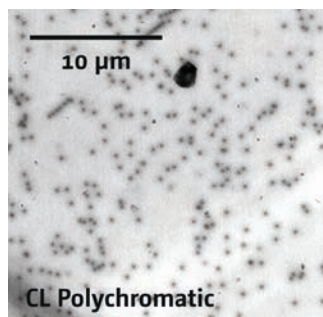
- Zero alignment: patented achromatic light microscope embedded in the column of a proprietary scanning electron microscope
- No compromise: up to 10 nm spatial resolution in both continuous and time-resolved mode from 3 kV to 10 kV
- Specimen benchmarking: very large field of view (300 μm) enabling quantitative cathodoluminescence
- High light collection efficiency: numerical aperture of 0,71 (f/0,5)
- Arbitrary movements: innovative 6-degrees-of-freedom nano-positioning stage (down to 1 nm displacement increments)
- Optional innovative low vibration cryostat for temperature measurements between 20K and 300K
- Optical hub for integration of the **Attolight CL** instrument in a larger spectroscopic system
- Optional Time-Resolved Cathodoluminescence (TRCL) mode: optimized for pulse operations up to 10 ps without any degradation of the spatial resolution. Enables lifetime and charge carrier dynamics measurements

Applications

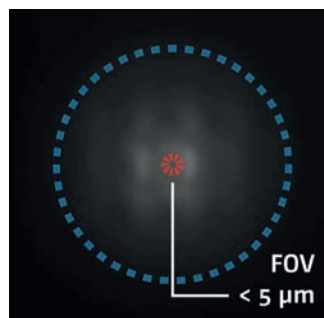
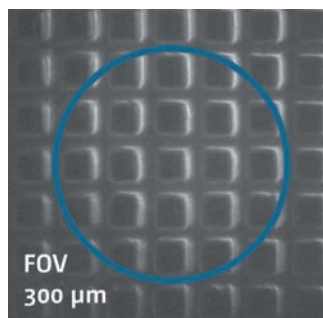
- LED performance and reliability
- GaN power transistors
- Threading Dislocation Density (TDD)
- Carriers lifetimes and dynamics
- Solar cells efficiency
- Development of nanoscale optoelectronic devices



ZnO nano-belts. The acquisition of a CL map (left) does not affect the detection of secondary electrons (right)



Cathodoluminescence is the ideal tool to measure threading dislocations density in GaN (left); they appear as dark spots because of non radiative recombination in their vicinity. A secondary electron scan of the same region cannot identify any threading dislocations (right).



Attolight optical microscope features constant resolution and photon collection efficiency over a field of view of 300 μm (left). Quantitative cathodoluminescence, i.e. comparison of emission intensities between various points is now possible. The traditional parabolic mirror approach is plagued by blur and vignetting (right).

Product Specifications

Measurements Mode

- Optical microscope imaging
- Cathodoluminescence mapping (polychromatic, monochromatic and hyperspectral)
- Secondary electrons (SE) mapping
- Time-resolved cathodoluminescence (time-resolved option)
- Simultaneous SE and CL imaging

Electron Optics

- Schottky field emission gun (continuous system) or picosecond pulsed photoelectron gun (time-resolved option). Acceleration voltage: 3–10 kV
- Electron optical column with electro-magnetic lenses, magnetic deflectors and astigmatism correctors. Optimized for continuous and pulsed operation.
- Highest spatial resolution: < 10 nm from 3 to 10 kV
- Analytical working distance: 3 mm
- No loss of SE resolution in cathodoluminescence mode
- Field-upgradable to picosecond pulsed photoelectron gun

Probe Current

- E-beam: 1pA to 20 nA

Light Optics

- Light microscope embedded within the electron optics
- Fully achromatic reflective objective: 180 nm – 1.6 μm
- Aperture: NA 0.71 (f/0.5)
- Field of View: >300 μm (electronic and optical)
- Optical Resolution: <5 μm
- Light collection efficiency: 30% of the photons emitted by a lambertian emitter exit the microscope (constant over the whole field of view)

Photon Detection

- Dispersive spectrometer with two imaging exits (320 mm focal length) and a 3-grating turret (gratings to be specified by customer at time of order)
- Detectors: PMT (exit 1), CCD (exit 2).

Time-Resolved Option

- 10 ps pulsed photoelectron gun
- Detector: UV-VIS streak camera

Chamber and Vacuum System

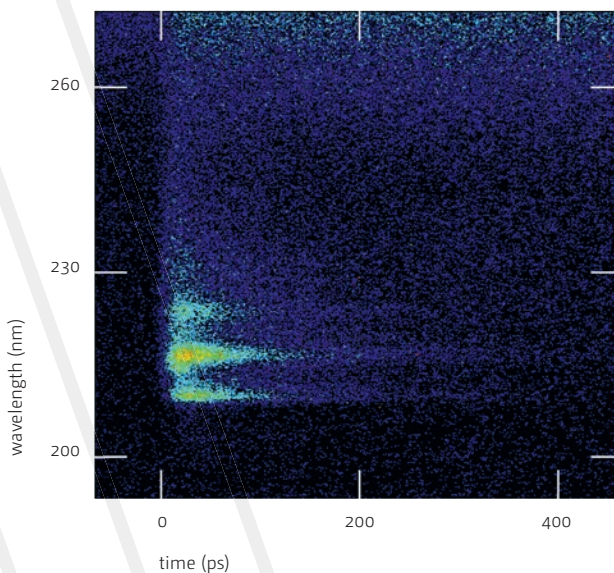
- Differential pumping system: ion getter pumps for electron gun and electron column. Turbo molecular pump for the specimen chamber. Specimen exchange time: 15 min.
- Internal chamber dimensions: 208 mm (diameter) x 300 mm (height)

Nanopositioning Stage

- Specimen diameter: $\varnothing$ 25x1.5 mm
- 6 degrees of freedom for arbitrary movements (compatible with cryostat option)
- Travel range: 25 mm (X and Y), 3 mm (Z), 3° tilt (X and Y), 35° rotation (Z)
- Smallest increment: 1nm
- Repeatability (full travel range): 100nm
- Repeatability (100 nm range): < 2nm

Low Temperature Cryostat

- Helium cold finger for low vibrations
- Minimal temperature range: 20K–300K
- Advanced digital temperature controller



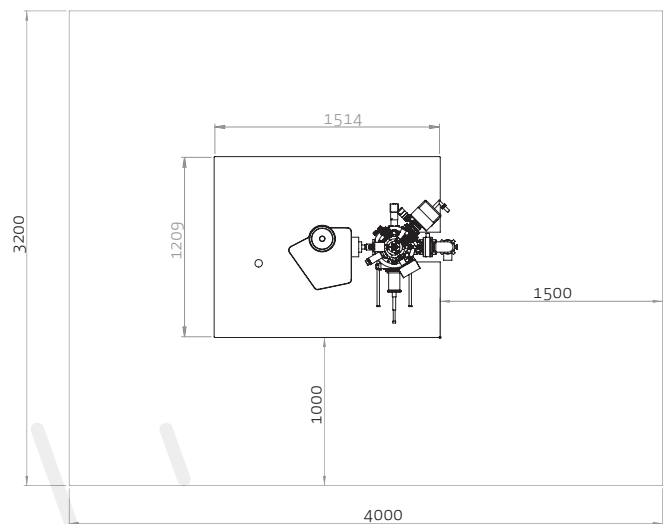
Time and spectrum-resolved cathodoluminescence of Boron Nitride. The spectrum is generated by focusing a pulsed electron beam on a specific point of the specimen. A streak camera is used for the detection. Deep UV spectroscopy becomes as simple as visible spectroscopy.

Facility Specifications

- Power: 7 standard wall plugs (230V, 50Hz) delivering 10A each
- Pressurized air for microscope valves and optical table, pressure of 551 kPa (80psi) max.
- Nitrogen to purge the chamber
- Weight:
 - CL system: 250 kg
 - Optical Table: 650kg
- Environment: temperature 20°C +/- 3°C, relative humidity below 70 % RH, stray AV magnetic fields
 - < 100 nT asynchronous
 - < 300 nT synchronous for line times > 20 ms (50 Hz mains)

Lay-out

The **Attolight CL** is mounted on an optical table with four active isolation legs. Its footprint is 1.2 m x 1.5 m. Allow for 1 to 1.5m space around the table to circulate and install an operator.





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