The **Allalin 4027** is a nanometer resolution spectroscopy instrument, based on a disruptive technology called low-temperature quantitative cathodoluminescence, that tightly integrates a scanning electron microscope, a light microscope and a cryogenic stage into one tool. It is designed for those who need to follow a tight technology roadmap and quickly access to extremely precise spectroscopic information that has been unavailable from traditional techniques.

In the semiconductor industry, the **Allalin 4027**’s 1600 color channels offer an unmatched solution for measurement of energy transfer in second generation solar cells and band-gap energy in Gallium Nitride based devices such as power transistors and LEDs. It can speed up technology development process and perform advance failure analysis (Indium clustering, band-gap shifts, etc.). In scientific and industrial research, the **Allalin 4027**’s ability to produce spectroscopic maps with nanometer resolution at various temperatures makes it the ultimate tool to obtain a deep insight into the physics of nanoscale objects.

The system was built from the ground up to achieve superior cathodoluminescence performance without compromising on the electron microscope performance: the light microscope and the objective lens of the scanning electron microscope are carefully intricated so that their focal planes match each other; the light microscope is machined with sub-micrometer precision in order to reach perfect achromatism, high numerical aperture (N.A. 0.71) and constant and superior photon collection efficiency over a field of view of 300 µm, so that quantitative cathodoluminescence benchmarking becomes possible for the first time; the electron microscope also operates at low electron beam energy (3–10 kV) for enhanced cathodoluminescence resolution. The **Allalin 4027** incorporates a 6-degrees-of-freedom cryogenic stage for arbitrary positioning of the specimen with 1nm increments and zero drift and vibration at low temperature (10–300 K).

The **Allalin 4027** includes a spectrometer, a high speed EMCCD camera, a zero-drift liquid Helium cryostat, a 6-degrees-of-freedom nano positioning stage and additional electronic hardware to run fast hyperspectral acquisitions.

### Key Benefits

- **Zero alignment**: patented achromatic light microscope embedded in the column of a proprietary scanning electron microscope. Operating the **Allalin 4027** is intuitive thanks to its context-based user interface and does not require to be an expert.
- **No compromise**: simultaneous generation of a SEM image and a hyperspectral CL image with no degradation of the electron probe size.
- **Quantitative**: the photon collection efficiency is constant over a large field of view of 300 µm with 0% photon loss due to vignetting in polychromatic mode; a mapping of 300 micron is performed without any displacement of the specimen; cathodoluminescence results are reproducible and comparable.
- **High light collection efficiency**: a numerical aperture of 0.71 (f/0.5) makes low emission cathodoluminescence a reality.
- **Low temperature stability**: acquire a hour-long map 10 K without observing any drift.
- **Nanometer positioning system**: nanometer scale measurements thanks to the most advanced nano positioning system ever built in an electron microscope.
- **Upgradable**: the core components (scanning electron microscope and light microscope) of the Grammont 2172, **Allalin 4027** and Rosa 4634 are the same; it is possible to upgrade anytime to another system by adding various modules.
- **Optical hub**: for integration of the Attolight CL instrument in a larger spectroscopic system.
Applications
– LED performance and reliability
– GaN power transistors
– Threading Dislocation Density (TDD) counting
– Failure analysis
– Solar cells efficiency
– Development of nanoscale optoelectronic devices

Hyperspectral mapping of different layers in a cross section of a GaN/AlGaN hetero structure

Product Specifications

Measurements Mode
– Cathodoluminescence mapping (polychromatic and monochromatic)
– Ultrafast hyperspectral mapping from 180 to 1100 nm
– Secondary electrons (SE) mapping
– Simultaneous SE and CL imaging

Electron Optics
– Schottky thermal field emission gun
– Acceleration voltage: 3–10 kV
– Electro-magnetic lenses, electrostatic deflectors and astigmatism correctors
– Electron optics optimized for continuous and pulsed operation
– Highest spatial resolution: 2.8 nm at 10 kV
– Optimum working distance: 3 mm (matches light microscope focal plane)
– High sensitivity SE detector
– No loss of SE resolution in cathodoluminescence mode
– Field-upgradable to pico-second pulsed photoelectron gun
– Electron probe current: 30 pA to 20 nA
– Maximum field of view: 600 µm at 3 kV

Light Optics
– Light microscope embedded within the electron optics
– Fully achromatic reflective objective from 180 nm to 1.6 µm wavelength, resulting in composite colors (e.g. yellow)
– Numerical aperture: NA 0.71 (f/0.5)
– Field of view: > 300 µm
– 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)

Light Detectors
– 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)
– High speed EMCCD camera for UV-Visible detection
– Ultrafast hyperspectral mode generates a 128 by 128 pixels map in 18 seconds

Chamber and Vacuum System
– Ion getter pumps for electron gun and electron column
– Turbo molecular pump for the specimen chamber
– Typical specimen exchange time: 20 min
– Internal chamber dimensions: 208 mm (diameter) x 300 mm (height)
– Electron beam and light microscope coincidence plane at 3 mm working distance

Nano-Positioning Stage
– 6 degrees of freedom for arbitrary movements (compatible with the cryostat)
– Travel range: 25 mm (X and Y), 3 mm (Z), 3° tilt (X and Y), 3° rotation (Z)
– Smallest increment: 1 nm
– Repeatability (full travel range): 100 nm
– Repeatability (100 nm range): < 2 nm

Low Temperature Cryostat
– Helium cold finger for low vibrations
– Minimal sample temperature range: 10 K – 300 K
– Advanced digital temperature controller

Sample size
– Maximum diameter: 25.4 mm
– Maximum thickness: 1.5 mm

System Control
– Hardware control and data server: 32 bit server with Windows® 7, 7 inch touchscreen monitor for system initialization, wifi router for connection to remote control
– User interface and remote control: wireless tablet computer with 2048 x 1536 touchscreen

Consumables (partial list)
– Replacement electron source module
– Aperture strip for electron beam
– Ion Getter Pumps

Installation Requirements
– Power: 1 standard wall plug (230 V, 50 Hz) delivering 10 A
– Weight: 800 kg
– Environment: temperature 20°C +/- 3°C, relative humidity below 60% RH, stray AV magnetic fields < 10 nT asynchronous < 300 nT synchronous for line times > 20 ms (50 Hz mains)
– Preferred door width: 120 cm (100 cm possible when removing isolator posts)
– Dry nitrogen: (0.1–0.5 bar)
– Compressed air: 551 kPa/80 psi, clean, dry and oil free

Common Upgrades
– Infrared: hyperspectral mapping up to 1600 nm
– Time-resolved: time-resolved cathodoluminescence measurements from 180 to 850 nm

Lay-out
The Attolight CL Tool sits on an optical breadboard mounted on 4 isolator posts to achieve vibration isolation. A typical recommended layout is shown below.

Attolight AG © 2017. We are constantly improving the performance of our products, so all specifications are subject to change without notice.
### Product Portfolio

#### Features and Benefits

<table>
<thead>
<tr>
<th>Feature</th>
<th>Grammont 2172</th>
<th>Allalin 4027</th>
<th>Rosa 4634</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>SEM</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Adjustable acceleration voltage</td>
<td>3–10 keV</td>
<td>3–10 keV</td>
<td>3–10 keV</td>
</tr>
<tr>
<td>Electron beam probe size</td>
<td>&lt; 2.8 nm</td>
<td>&lt; 2.8 nm</td>
<td>&lt; 2.8 nm</td>
</tr>
<tr>
<td>Optimized for continuous and pulsed operation</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Light microscope embedded within the electron optics</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td><strong>CL</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Monochromatic mode</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Polychromatic mode</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Hyper spectral mode</td>
<td>No</td>
<td>Ultrafast</td>
<td>Ultrafast</td>
</tr>
<tr>
<td>UV-Visible range</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Near Infra Red (NIR) range</td>
<td>No</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Field of View (µm) with 0% photon loss due to vignetting in polychromatic mode</td>
<td>300</td>
<td>300</td>
<td>300</td>
</tr>
<tr>
<td>High Light Collection Efficiency</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>No vignetting</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Quantitative Measurements</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Easy alignment</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Number of degrees of freedom for the positioning</td>
<td>3</td>
<td>6</td>
<td>6</td>
</tr>
<tr>
<td><strong>Additional Features</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Touchscreen remote control device</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Sample Positioning accuracy</td>
<td>1 nm</td>
<td>1 nm</td>
<td>1 nm</td>
</tr>
<tr>
<td>Easy Sample Repositioning</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Sample Temperature Control</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Mounted on a optical table</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td><strong>Software</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Proprietary Attolight GUI controlling both SEM and CL</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Visualization software for Hyper spectral maps</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td><strong>Option Névé</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Temperature from 10 to 350 K with 0.1 K stability / Zero drift / Zero vibration / Easy sample repositioning</td>
<td>No</td>
<td>Included</td>
<td>Included</td>
</tr>
<tr>
<td><strong>Ultrafast Hyperspectral Upgrade</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Ultrafast hyper spectral mode in the UV-Vis range</td>
<td>No</td>
<td>Included</td>
<td>Included</td>
</tr>
<tr>
<td><strong>Ultrafast IR Upgrade</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Ultrafast hyper spectral mode in the NIR range</td>
<td>No</td>
<td>No</td>
<td>Included</td>
</tr>
</tbody>
</table>