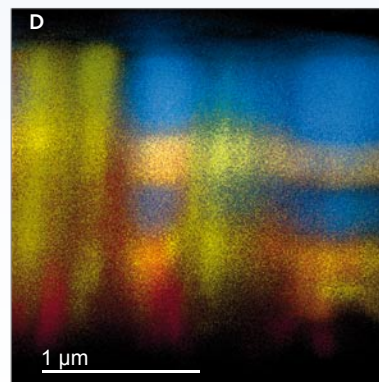
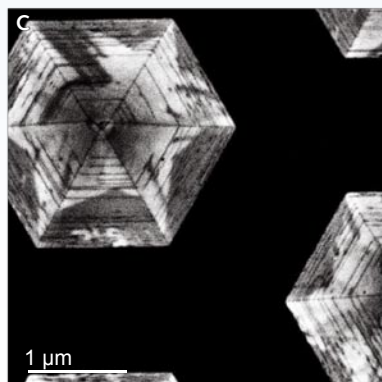
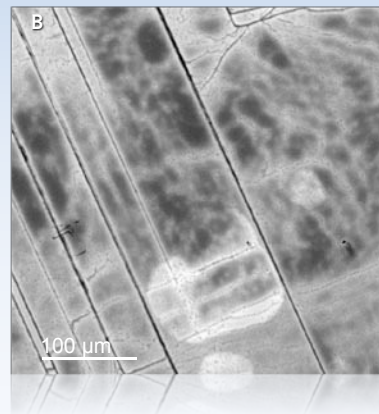
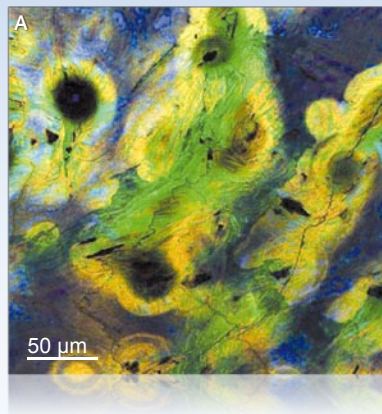


MonoCL4

World-leading cathodoluminescence systems



High resolution CL imaging and spectroscopy



The New Generation

MonoCL4 is the next generation in the world-leading family of cathodoluminescence (CL) systems from Gatan. MonoCL has been synonymous with high resolution CL imaging and spectroscopy for more than 15 years, with hundreds of successful installations on SEMs, TEMs and electron microprobes. New advances in performance and functionality ensure that the MonoCL family remains at the cutting edge of CL today and for tomorrow.

The MonoCL design continues to provide unrivalled sensitivity by maximising light collection efficiency and using direct optical coupling through a chamber-mounted monochromator to high efficiency detectors. In this way losses are minimised and maximum sensitivity is achieved across a broad spectral range allowing:

- Low injection conditions for high spatial resolution, avoiding non-equilibrium conditions and minimising beam-induced artefacts
- Narrow band pass operation for high spectral resolution and monochromatic imaging
- Shorter acquisition times for enhanced productivity
- CL applications for many specimens, even from SEMs with limited beam current
- CL from restricted generation volumes e.g. thin films, nanowires, nanoparticles and TEM specimens

Advanced Applications

CL is a potent photonic characterisation tool capable of spectroscopic analysis with high spatial resolution and depth of field based upon the power and flexibility of an electron probe.

MonoCL users have advanced the understanding of semiconductor and optoelectronic materials from nitride semiconductor thin-films, nanostructures and heterostructures to nanostructured oxides (ZnO, ZrO₂ and Y₃Al₅O₁₂), indium phosphide and rare earth doped materials. Even though silicon is a poor emitter of light, the supreme collection efficiency, dispersion and detection of MonoCL have allowed



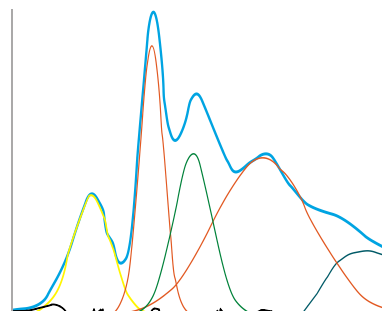
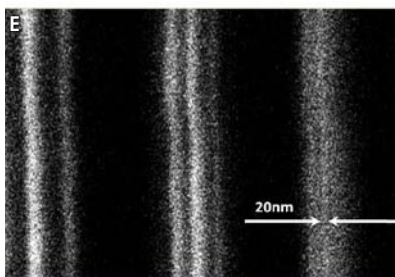
In the pharmaceutical industry, CL can allow high throughput screening of active pharmaceutical ingredients and offer spectral fingerprinting, also valuable in forensic and food science applications.

For life sciences the use of luminescent markers combines the benefits of fluorescence microscopy with the spatial resolution capabilities of an electron microscope.

CL to become an important characterisation technique for silicon-based materials for photovoltaic and light emission applications.

For geological applications CL is invaluable for establishing provenance and diagenesis, providing an easy means of differentiating minerals, observing healed fractures and chemical overgrowths and identifying fine zone structures.

CL is suitable for almost all non-metallic materials and even some metallic structures where observing surface plasmon modes is an emerging application.



Optimised CL Configurations

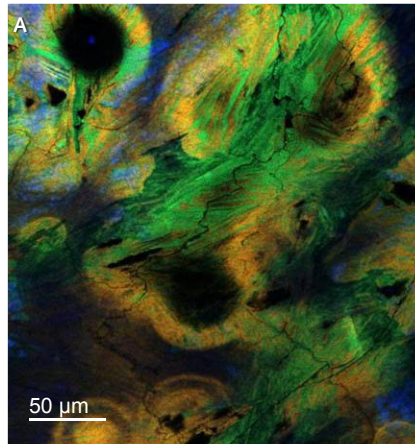
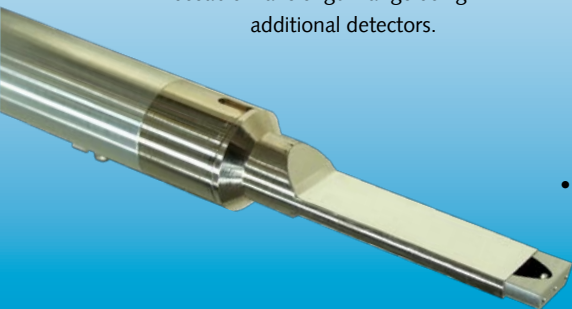
The **MonoCL4** family of products provides a range of high performance CL solutions individually engineered to your microscopy needs. The core MonoCL4 product offers:

- Panchromatic and monochromatic imaging with high spatial and spectral resolution
- 'Point and click' selection of spectroscopy, imaging and mapping modes
- Shortpass, longpass and bandpass imaging using filter options for increased flexibility
- Detector and diffraction grating options optimised for your application in the ultra violet, visible and infra red wavelength ranges
- Computer and/or manual control of detector settings



- Factory recorded spectral response files
- Enhanced sensitivity in the ultra violet and infra red wavelengths
- UV optimised option, allowing analysis to wavelengths below 200nm
- Time evolved signal monitoring
- New design and software features make the interchange of gratings easier than ever whilst maintaining spectral calibration

The modular structure allows convenient and cost effective upgrade paths to the premium packages or to extend the useable wavelength range using additional detectors.



MonoCL4 Swift includes an additional array detector enabling

- Rapid 'parallel' spectral acquisition for superior productivity
- Crucial to obtaining results from beam sensitive specimens.

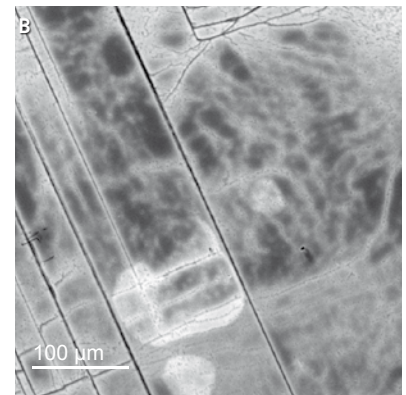
MonoCL4 Plus offers supreme sensitivity and flexibility. It includes a cooled, high sensitivity PMT and the high performance DigiScan II™ digital beam control system, for high-bit image acquisition, processing and analysis, enhancing SEM imaging performance and extending applications.

- Simultaneous acquisition of multiple imaging and mapping inputs
- Wide flexibility of pixel density and dwell times – key for many CL applications
- Quantitative pulse mapping (complements standard analogue imaging)
- Linescan mapping function
- Multiple image overlay facility with drift correction

MonoCL4 Elite is the ultimate CL package, combining the speed of MonoCL4 Swift and the sensitivity of MonoCL4 Plus and incorporating advanced analysis options using Gatan's industry leading spectrum-imaging (SI) software.

- Allows bandpass images to be extracted as a post-processing step

- MLLS fitting of data using reference spectra to produce fit-coefficient maps
- Gaussian curves can be fitted to spectra providing amplitude, peak-shift & -width mapping. Useful for mapping changes in alloy composition and stress mapping in semiconductor and ceramic materials
- Sub-pixel scanning for improved statistical confidence
- Stage mapping option for extended field of view
- Simultaneous SI acquisition of other signals available e.g. EDS or EELS



Compatibility

Compatible with conventional, low vacuum or field emission SEMs, combined FIB/SEMs and ion microscopes. Special versions for microprobes, (S)TEMs or UHV chambers.

MonoCL4 is fully compatible with Gatan's range of nitrogen and helium cooled stages, for enhancing the CL signal and increasing spectral discrimination for ease of interpretation - the complete solution!

SmartEBIC, Gatan's quantitative EBIC system can also share the MonoCL4

A Metamorphic re-crystallisation of polycrystalline diamond. Dr E. Vicenzi, Smithsonian Institution, Washington D.C.

B CdZnTe showing dislocations, sub-grain boundaries, doping, alloy and impurity segregation, twins and stacking faults.

C AlGaIn pyramid structure containing internal defects.

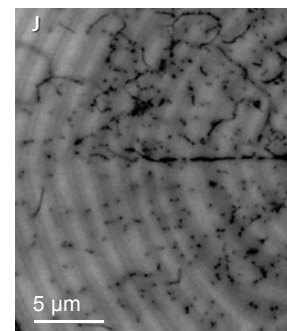
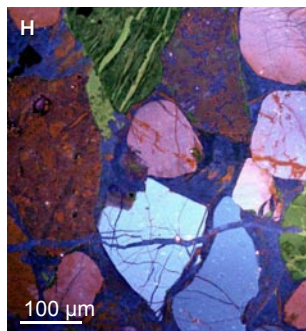
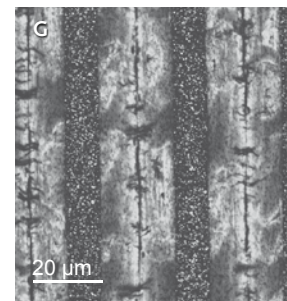
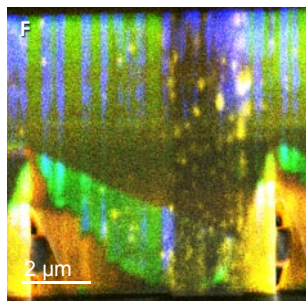
D AlGaIn film cross section. Composite image, false coloured using DigiScan colour mix facility. Temperature = 6K. Dr U. Jahn, Paul Drude Institute, Berlin.

E GaAs/AlAs/AlGaAs MQW structure. 20nm quantum wells and barrier structures are resolved. Dr C. Norman, Toshiba Research Europe Ltd.

MonoCL4 Specifications and Recommendations

	MonoCL4	MonoCL4 Swift	MonoCL4 Plus	MonoCL4 Elite
Collection mirror				
Retractable, detachable, diamond-turned mirror	✓	✓	✓	✓
Alternative short working distance mirror ¹	★	★	★	★
Additional multi-signal mirror	★	★	★	★
Extended retraction ¹	★	★	★	★
Spectrometer				
Direct optical coupling to chamber-mounted monochromator	✓	✓	✓	✓
Software control of imaging/spectroscopy acquisition	✓	✓	✓	✓
Auto-calibration of spectrometer	✓	✓	✓	✓
Single grating, choice of blaze and dispersion	✓	✓	✓	✓
Second grating, choice of blaze and dispersion	★	✓	★	✓
Additional, fully calibrated diffraction gratings ²	★	★	★	★
High efficiency achromatic optics	✓	✓	✓	✓
UV optimised system	★	★	★	★
Imaging options				
Imaging to SEM (requires AUX input on SEM)	✓	✓	✓	✓
DigiScanII™ (requires external scan control on SEM)	★	★	✓	✓
Pulse mapping (requires DigiScanII™)	★	★	✓	✓
Panchromatic imaging	✓	✓	✓	✓
Monochromatic imaging	✓	✓	✓	✓
4-position filter housing with RGB filter set	✓	✓	✓	✓
Additional 50 - 80 nm band pass filter set	★	★	✓	✓
Additional filter options	★	★	★	★
Spectroscopy				
Photon counting 'serial' spectroscopy	✓	✓	✓	✓
Fast spectroscopy using CCD or array detector	⬆	✓	⬆	✓
In-line spectral calibration lamp	✓	✓	✓	✓
Spectral response files (350 nm – upper limit of detectors)	✓	✓	✓	✓
Detector options				
Standard PMT (185 - 850 nm)	✓	✓	■	■
High sensitivity PMT (160 - 930 nm). Includes Peltier-cooled housing ³	★	★	✓	✓
Infra red PMT. Includes liquid nitrogen-cooled housing ^{3,4}	★	★	★	★
Extended range PMT. Includes Peltier-cooled housing ³	★	★	★	★
Infra red, liquid nitrogen-cooled InGaAs detector ¹	★	★	★	★
CCD for parallel spectroscopy (200 - 1100 nm) ⁴	⬆	✓	⬆	✓
Optimised parallel IR system with InGaAs array ¹	⬆	★	⬆	★
Spectrum-imaging				
Beam controlled spectrum-imaging	⬆	⬆	⬆	✓
Stage controlled spectrum-imaging ⁵	⬆	⬆	⬆	★
Simultaneous CL and EDS/EELS spectrum-imaging ⁶	⬆	⬆	⬆	★
Software				
Gatan Microscopy Suite, DigitalMicrograph™ software	✓	✓	✓	✓
Additional hardware				
PC with flat screen, CDRW drive	✓	✓	✓	✓
SmartEBIC ⁷	★	★	★	★
Cryogenic stages and modules	★	★	★	★

Key	
✓	Yes
■	Not applicable
★	Option
⬆	Upgrade path available



- F GaN film in cross section. Composite image of stacking fault, threading dislocation, point defect and band gap luminescence. Temperature = 6K.
- G Nitride ELO structure. Specimen provided by Prof. Sawaki, Nagoya University, image taken by Mr Yanagihara, JEOL.
- H Fractured and healed quartz grains. Dr R. Reed, Bureau of Economic Geology, University of Texas.
- J Plan view GaN showing threading dislocations and impurity segregation.

- 1 Recommended for certain SEMs. Please ask for details
- 2 Two diffraction gratings may be fitted simultaneously. Additional, fully calibrated gratings are user exchangeable
- 3 Instead of standard PMT
- 4 Choice of wavelength ranges and/or detector device available
- 5 Not available for every SEM. Please ask for details
- 6 Simultaneous acquisition is not compatible with all third party vendor equipment and may require additional software to be purchased from third party. Multi-signal mirror required.
- 7 Shared hardware and software



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