Specimen Cooling Stage Modules

Models C1000 and CF302

There are many benefits of specimen cooling in the scanning electron microscope (SEM). Beam sensitive materials, such as polymers and geological samples, are stabilized, even under the high beam currents used for microanalysis. Low temperature phases and the performance of semiconductor and superconductor materials can be studied.

Semiconductor materials can also be analyzed using techniques such as cathodoluminescence (CL) or electron beam induced current (EBIC). Enhanced CL efficiency is often achieved by specimen cooling as low temperatures reduce the probability of competing non-radiative recombination events. Precise requirements and benefits of specimen cooling will depend on the specimens to be studied. However, general specimen cooling can increase CL signal intensity and will improve spectroscopic discrimination, allowing increased understanding of the optoelectronic properties. Helium cooling becomes more critical in the study of indirect band gap semiconductors.

In addition, as CL efficiency becomes stronger with cooling, lower injection conditions may be used, which provides the key to achieving higher spatial resolution using small spot sizes and low accelerating voltages.

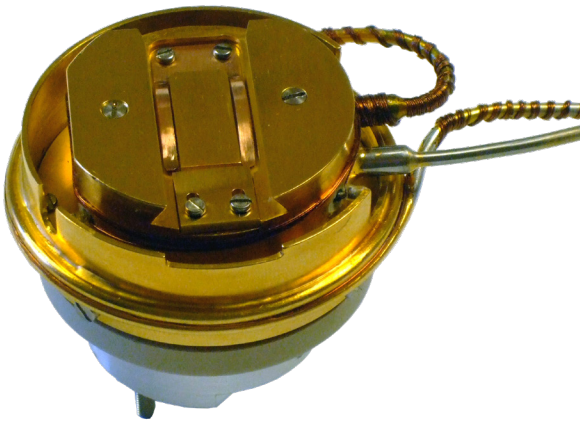


Figure 1. Helium cooled SEM stage module, model CF302M.

Benefits

- **Cryogenic gas cooling**: Fast cool-down, avoids vibration, allows stage movements
- **Cryogen dewar remote from the SEM:** Avoids vibration, saves valuable space on SEM chamber
- **Dovetail sample holders:** Good heat transfer for low sample temperatures; airlock loadable*
- **Extended temperature range options:** Versatile for multiple applications

Applications

- Stabilizing beam sensitive materials
- Studies of low temperature phases
- Semiconductor and conductor research
- Improved CL intensity and spectroscopic discrimination

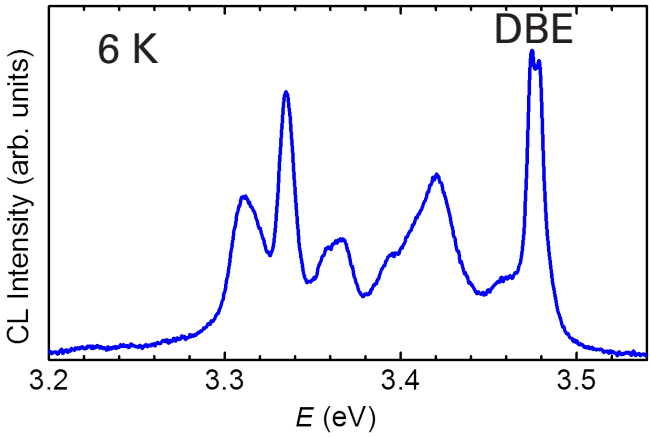


Figure 2. CL spectrum and composite monochromatic images of a GaN micro-crystal showing the donor-bound exciton at the band edge (DBE) plus additional sharp peaks associated with stacking faults, which can only be detected at low temperatures. *Data obtained using a MonoCL system with CF302 helium-cooled stage by J. Lähnemann, Paul Drude Institute, Berlin.*

For EBIC studies, reducing the temperature can change the recombination behavior of defects as well as the density and diffusion of carriers. Cooling also reduces thermal noise and allows higher gain settings of the EBIC electronics.

Nitrogen cooling and heating modules

Gatan cooling stages and heating stage modules use a dovetail specimen holder to ensure good heat transfer and to allow specimen transfer through an airlock*. In addition to temperature sensing and control provided as standard, there is an option to provide electrical connections to the sample holder for further studies.

C1000 series nitrogen cooling modules interface easily to most standard SEM stages and are compatible with all types of SEM and focused ion beam SEM (FIB-SEM), also with other Gatan products, e.g., anticontaminator, airlock, vacuum transfer, CL and EBIC.

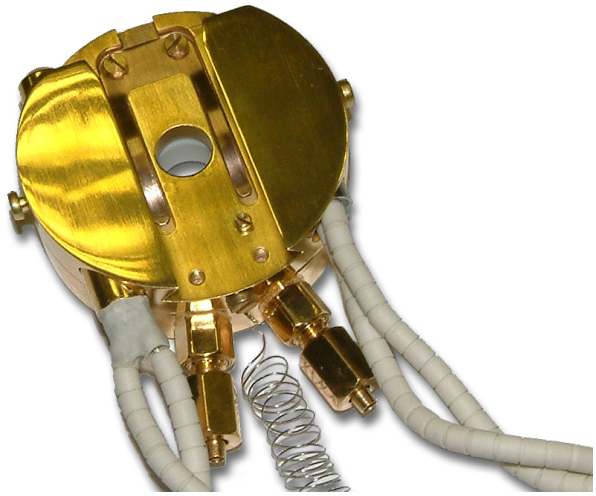


Figure 3. Nitrogen cooled SEM stage module, model C1002.

Dry nitrogen gas is circulated through the module via cryogenic tubing. This allows rapid cool down, high resolution imaging (low vibration) and reasonable stage movements.

A heater and sensor are fitted to the module and a digital temperature controller is provided allowing precise temperature control. With C1002 and C1003 versions, the specimen may be heated as well as cooled (in this case the gas flow is turned off for heating above ambient).

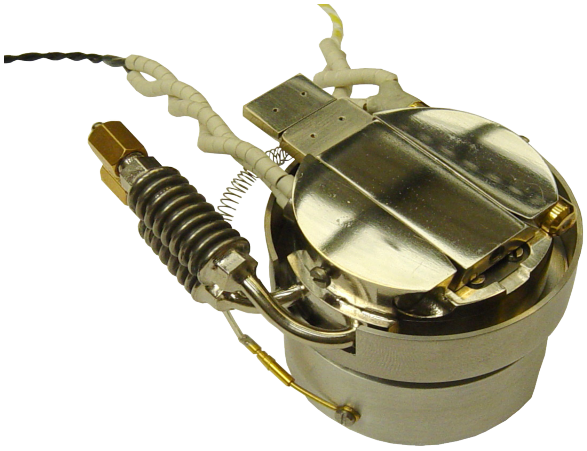


Figure 4. Nitrogen cooled SEM stage module, model C1003.

A range of specimen stubs and holders is available, to allow a variety of specimens to be examined.

Nitrogen cooled anticontaminators are invaluable to improve the cleanliness of SEM chamber vacuum, especially to reduce contamination of a cold specimen surface. C1000 series anticontaminators can either be provided in series with the nitrogen cooling module or stand alone. The configuration of the anticontaminator will be optimized to suit the customer's SEM or FIB-SEM chamber layout.

Helium cooling module and stage

Helium cooling stages, models CF302 and CF302M, utilize continuous flow technology, sample cooldown is rapid to a low base temperature and reasonable stage movements can be made.

A low-loss vacuum insulated transfer tube, with shielding cooled by the exhaust helium gas and a sophisticated temperature controller ensure a low helium consumption.

Model CF302 helium cooling stage comes complete with a replacement stage door for the SEM, including X,Y,Z micrometer stage drives and a convenient vacuum storage chamber to keep the stage clean when not in use. It will be necessary to ensure you can remove the original stage from the SEM.

A dual fuel upgrade is available to allow the helium cooling stages and modules to be cooled using nitrogen gas, thus economizing on the cost of cryogens.

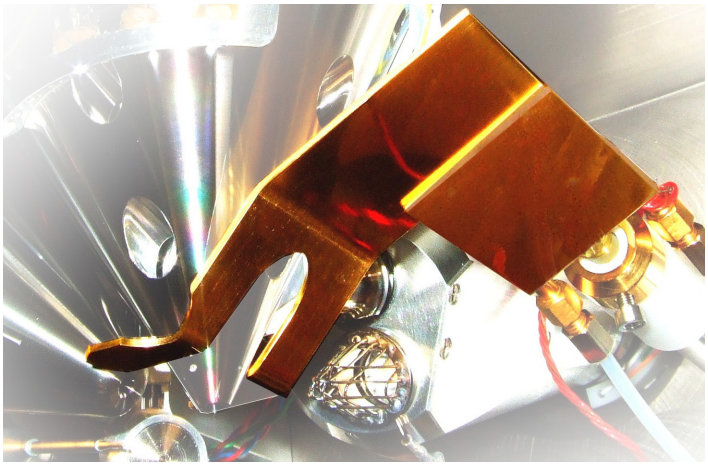
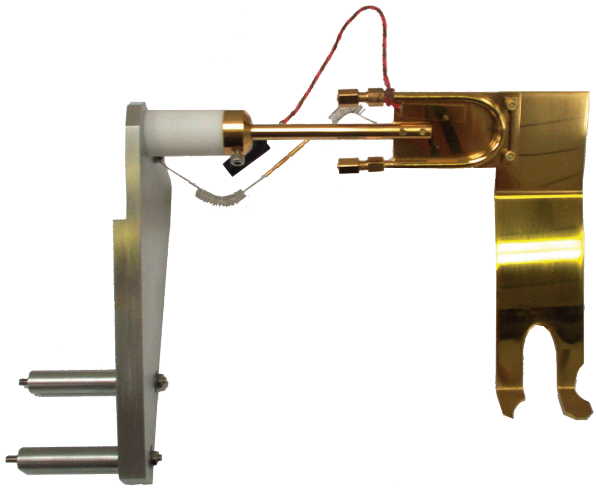


Figure 5. Anticontaminator blade, shaped and with cut-outs to allow high specimen tilt and access by energy dispersive x-ray spectroscopy (EDX), retractable back-scatter detectors and FIB accessories.

Specifications

C1000 series nitrogen modules	
Dovetail sample holder (mm)	
Overall dimensions (L x W x H) Stub diameter	28 x 13 x 4 10
Cooling system	Dry N_2 gas, cooled by LN_2 in a remote dewar. Temperature sensor and heater in module for control and for heating.
Temperature ranges (°C)	
C1001 C1002 C1003	-185 to ambient -185 to +200 -185 to +400
Cool down time, ambient to -185 °C (min)	<10
Temperature accuracy (°C)	0.5
Typical available movement (°)	
X,Y,Z tilt Rotation	~50 ~±25
Anticontaminator options, base temperature (°C)	Less than -190

Specifications are subject to change.



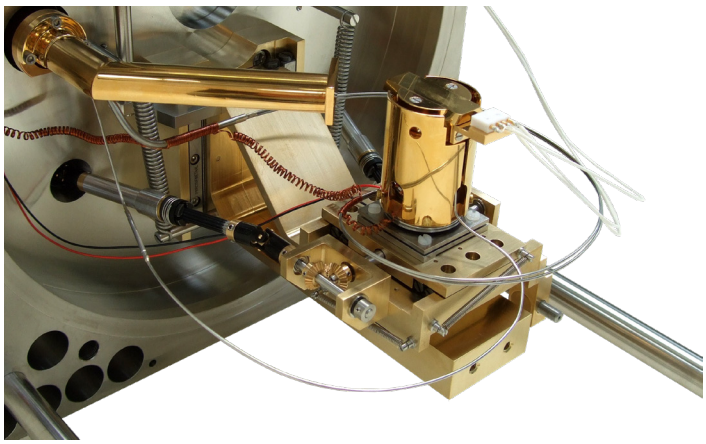


Figure 6. Helium cooled stage, model CF302, to exchange with standard SEM stage and door.

CF302 helium stage, CF302M module	
Dovetail sample holder dimensions (L x W x H, mm)	41 x 13 x 4
Cooling system	Continuous flow helium, supplied via vacuum insulated transfer tube. Temperature sensor and heater in module for control.
Temperature ranges (K)	
CF302 CF302M CF302DF option	6 (±1) to 140 8 (±1) to 140 100 – 300
Cooldown time, ambient to base temperature (min)	~45
Temperature accuracy (K)	±0.5
Typical available movement, depends on SEM (mm per axis)	
CF302: Replacement stage with manual X,Y,Z CF302M	±10 ±10

Ordering

CF302 and CF302M

Model	Description
CF302	Helium cooled stage (6 K ±1 degree), supplied to replace SEM stage and door Includes heater, sensor, sample holder, low-loss flexible helium transfer tube, gas flow pump and controller, digital temperature controller
CF302M	Helium cooled stage module (8 K ±1 degree) Includes heater, sensor, sample holder, low-loss flexible helium transfer tube, gas flow pump and controller, digital temperature controller
Options	
CF302TC	Electrical connections for CF302 or CF302M, including CF121 electrical sample holder with 4 connections
CF302DF	Dual fuel upgrade kit to allow CF302 or CF302M to be nitrogen cooled (100 K to 300 K)
ASC101	Motorization upgrade for CF302, including X,Y motor drives, controller
ALT329	30 L self-pressurizing dewar, for dry N_2 gas supply to CF302DF

Other specimen holders available.

C1000 series

Model	Description
C1001	Cold stage module, -185 °C to ambient, N_2 gas cooled with heat exchange dewar, interface to SEM, gas regulator, specimen holder with stub, heater, temperature sensor and digital temperature controller NB A source of dry and liquid N_2 gas is required
C1002	As C1001 but with temperature range: -185 to +200 °C
C1003	As C1001 but with temperature range: -185 to +400 °C
C1006	Anticontaminator, N_2 cooled
C1007	Anticontaminator, N_2 cooled, with temperature controller
Options	
C1002TC	Electrical connections for C1001 or C1002 module, including CR15121 electrical sample holder with 4 connections
C1003TC	As C1002TC but for C1003 module
C1005	Anticontaminator upgrade for cold stage module (uses same cooling circuit)
C1005B	Option for anticontaminator to remain cold when cold stage module >50 °C

*Airlock adapters available for some SEM airlocks.

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