MicrostatHiResII

Helium, high resolution continuous flow optical cryostat

High resolution small signal measurements and spatial mapping require that the mechanical stability of a cryostat exceeds the optical spatial resolution for the duration of the experiment.

The MicrostatHiResII is a vacuum loading continuous flow cryostat that benefits from extremely low sample vibration and sample drift at both constant and changing temperatures.

Applications

The high mechanical stability of the MicrostatHiResII makes this cryostat ideally suited for applications such as:

- Micro-Raman mapping of semiconductor microstructures with sub-micron spatial resolution.
- Micro-photoluminescence mapping of semiconductor microstructures with sub-micron spatial resolution.

Components

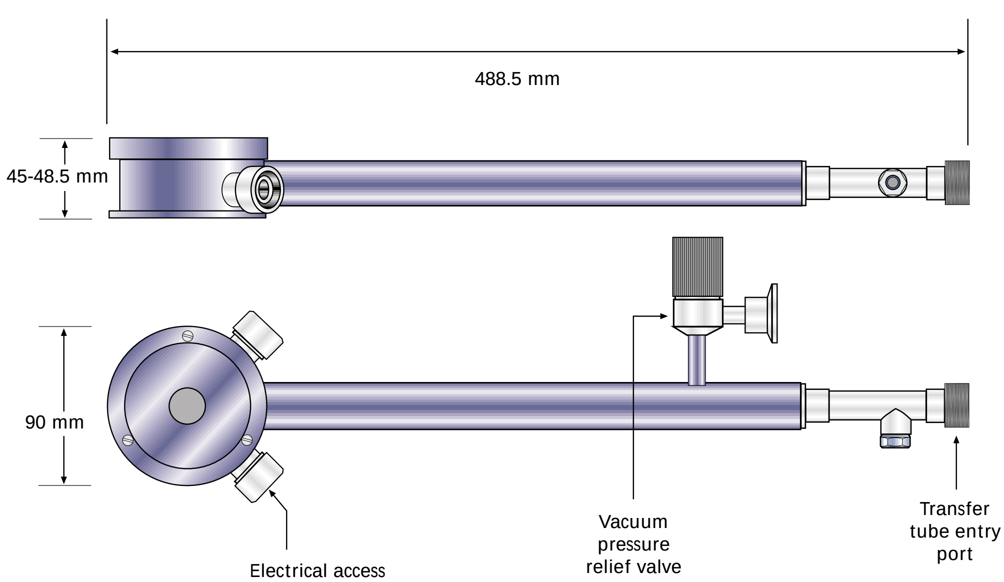
The MicrostatHiResII system consists of:

- MicrostatHiResII high resolution continuous flow optical cryostat
- Sample holder
- Transfer tube
- ITC temperature controller
- Gas flow pump (for 3.2 K operation)
- Rotary pump (option for 2.7 K operation)
- Gas flow controller

Features and benefits

- High mechanical integrity – provides low sample vibration and drift to maintain high resolution measurements over many hours
- Extremely short optical working distance – accommodates easy interfacing to microscope objectives and enables high magnification – optics to achieve sub-micron spatial resolution
- Adjustable top flange – allows highest magnification optics to be used without changing sample holders when investigating samples of different thicknesses
- 2.7 K to 500 K operation capability – enables high resolution measurements under both constant and changing temperatures

MicrostatHiResII dimensions



Quantum Ordered Systems

Brian Fluegel, Steve Smith and Angelo Mascarenhas of the National Renewable Energy Laboratory (NREL) in Golden, Colorado, are undertaking photo-luminescence experiments with the aid of a MicrostatHiResII. The high-spatial resolution of the micro-photoluminescence (micro-PL) has enabled them to examine the optoelectronic properties of ordered-Gallium Indium Phosphide ($GaInxP1$-x) alloys (x=0.48) on a sub-micron length-scale.

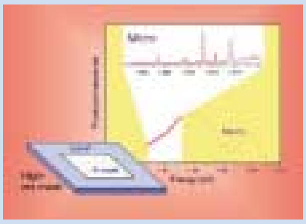


Illustration of GaInP sample with opaque mask (left). An 'expanded' view of the macro-PL spectra at 5 K shows many quantum-dot like transitions, revealed by the micro-PL spectra (using the MicrostatHiRes)

Operation

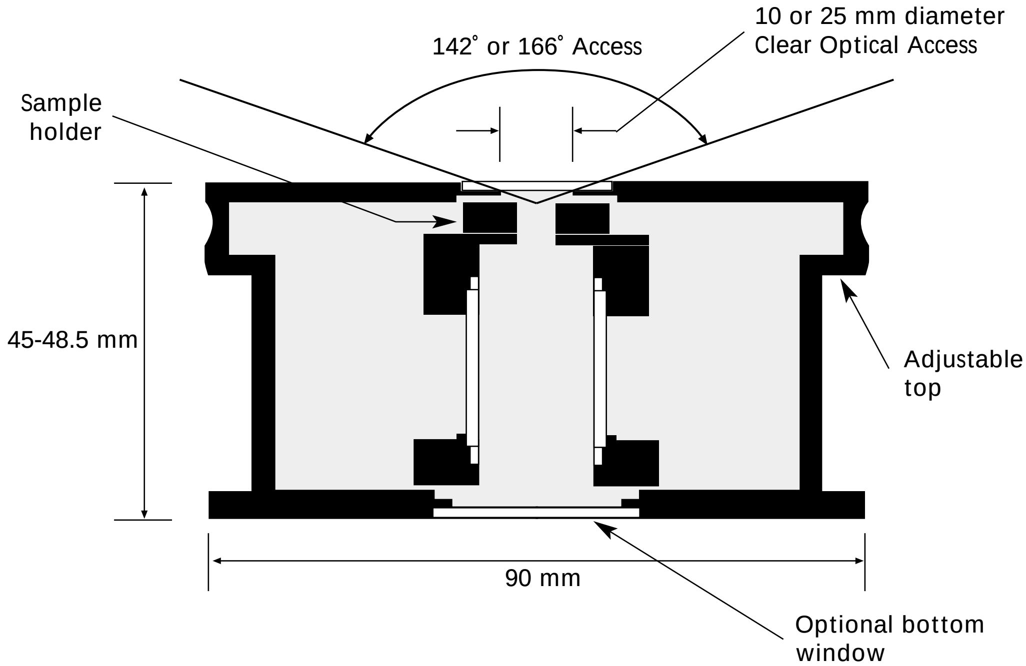
The MicrostatHiResII is a vacuum loading continuous flow cryostat. Liquid cryogen is drawn from a separate helium storage dewar and circulated through the heat exchanger in the cryostat. The sample holder is thermally anchored to the heat exchanger and surrounded by vacuum. The returning helium gas flows along the transfer tube to the exhaust port, and the exhaust line is linked to a helium gas flow controller and a small gas flow pump. The cryogen flow to the heat exchanger is regulated by a needle valve on the transfer tube. An optional stepper motor is available to automate this operation through an Intelligent Temperature Controller (ITC), which significantly reduces cryogen consumption. With the controlled flow of helium, the MicrostatHiResII quickly cools down to 4.2 K (Typically in about 15 minutes).

Temperatures below 4.2 K are achieved by lowering the pressure in the heat exchanger, whilst precise temperature control from 4.2 K to 500 K is achieved using a temperature controller varying the temperature of the heat exchanger. The MicrostatHiResII can also be used with liquid nitrogen.

Adjustments to the top flange position of the optical cryostat enable variation in the working distance to the sample and its thickness.

Window options

A 0.5 mm thick Spectrosil B quartz window is fitted as standard. However, a wide range of window materials are available on request. For example, for infrared measurements ZnSe or KRS5 windows may be fitted (see windows data sheet). A 1.5 mm thick window is also available enabling a clear optical access of 25 mm.



Schematic cross-section view of MicrostatHiResII

MicrostatHiResII Specifications

Optical specifications	Window thickness 0.5 mm	Window thickness 1.5 mm
Clear access diameter	10 mm	25 mm
Sample holder to window top surface	2.2 mm	2.2 mm
Angle of admittance (to surface of sample holder at centre)	142˚	166˚
Max sample thickness	5 mm	4 mm
Max sample diameter	20 mm	20 mm

All dimensions are approximate and relate to top window with plane sample holder in central position

Standard Specification	**Description**
Cooling medium	Liquid helium (can be used with liquid nitrogen)
Operating temperature range	2.7 K to 500 K
Base temperature	3.2 K with GF4 pump, 2.7 K with EPS40 pump
Temperature stability	+/-0.1 K
Helium consumption	<0.75 lhr^{-1} (at 4.2 K)
Cool down time	From ambient to 4.2 K with transfer tube cold = 15 minutes
Lateral sample holder drift at constant temperature	0.15 µm per hour (typical), at 4.2 K after 1.5 hours stabilisation (see note 1)
Lateral sample holder drift on changing temperature	13 µm (typical) cooling from 300 K to 4.2 K (see note 1)
Sample holder vibration	<20 nm (see note 2)
Sample holder diameter	20 mm
Adjustable distance of top flange	3.5 mm
Helium consumption	0.75 lhr^{-1} (at 4.2 K)
Sample window material	Spectrosil B fused quartz Other materials available on request
Standard temperature sensor	3 point calibrated rhodium iron
Sample change time	1 hour (approx.)
Weight	1.5 Kg

Please note these measurements are approximate. The stability is neither measured nor guaranteed and will be dependent upon the final system's configuration and the environment the equipment is used in.

1. All specifications refer to the base model cryostat with one Spectrosil B window, used with liquid helium and LLT transfer tube and an ITC temperature controller.

2. This low temperature vibration and drift data was taken using a Leo 1540 VP Scanning Electron Microscope. Users should ensure their MicrostatHiResII is firmly secured to achieve this high resolution.

System Components

MICROHR2	MicrostatHiResII cryostat
QOVC05HR2	Cryostat top flange with 0.5 mm thick, 10 mm diameter optical access Spectrosil B fused quartz window
BBPHR2	Blank base plate
VH4HR2	Sample holder, up to 5 mm thick samples
LLT600/13	Low loss transfer tube with 1.3 m long dewar leg
GF4	Gas flow pump
VC31	Gas flow controller with helium flow meter
ITC503	Temperature controller
CC1	3 m cryostat cable, 10-pin connector
SV12	Storage vessel top fitting with bladder and valve
SKHIRES2	Spares kit (O-rings)

Standard Options

QOVC15HR2	Cryostat top flange with 1.5 m thick, 25 mm diameter optical access Spectrosil B fused quartz window
QOVCB15HR2	Cryostat base flange with 1.5 m thick, 25 mm diameter optical access Spectrosil B fused quartz window
TSH4HR2	Transmission sample holder, 5 mm through hole
LLT650/13	Automated version of the LLT600/13
LX10	10-pin electrical seal wired to terminals above heat exchanger
CX1	Miniature coaxial connector wired to sample holder
HD30	30 litre helium dewar
ITC502 or ITC601	Temperature controller
EPS40	40 m^3hr^{-1} helium pumping system for operation at 2.7K
HVP4	High vacuum pumping system
VC41	Gas flow controller with helium and nitrogen flowmeters
MICROSTATBTPIL2	Pillared version for use with magnets

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