Helium, continuous flow optical cryostat

The vacuum loading MicrostatHe cryostat is specifically designed for microscopy applications requiring temperatures down to 2.2 K. It is also ideal for experiments where a small working distance and thin window is required to minimise spherical aberration.

Applications

The MicrostatHe has been designed for the following applications:

- Photoluminescence
- Raman scattering
- Reflectivity and adsorption studies
- Scanning optical microscopy and micro-probe measurements

When used with high magnification microscopes, for example, it enables measurements such as the Kerr effect.

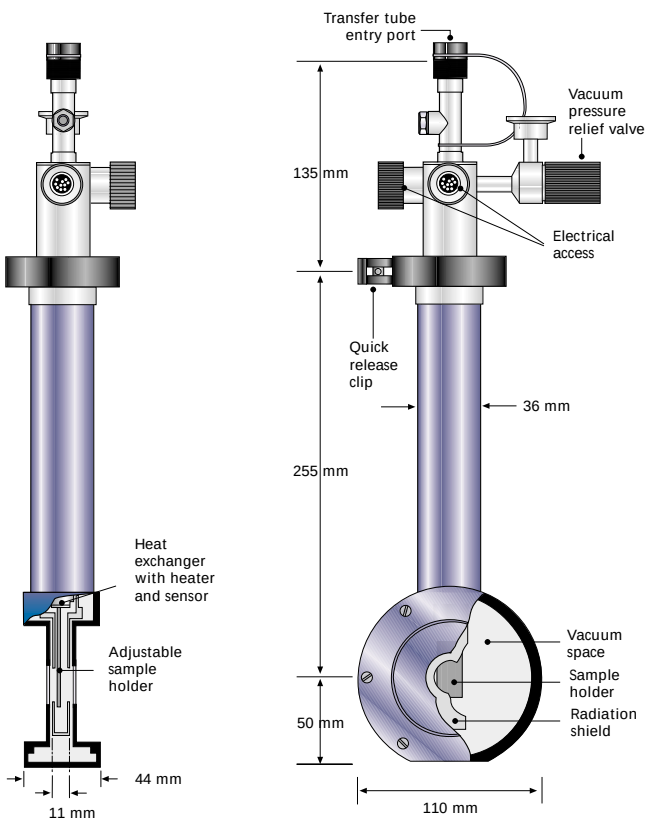
Components

The MicrostatHe system consists of:

- MicrostatHe continuous flow optical cryostat
- Sample holder(s)
- Transfer tube
- ITC temperature controller
- Gas flow pump (for 3.2 K operation)
- Rotary pump (option for 2.2 K operation)
- Gas flow controller

Features and Benefits

- Wide temperature range – rapid response to required temperature changes from 2.2 K – 500 K with optimised thermal design to provide excellent control and stability of sample temperature
- Economical use of cryogens – easy to use liquid helium based system to provide rapid cool down: <10 mins to 4.2 K. Liquid helium consumption as low as 0.45 l/h^{-1}
- Range of demountable windows – for measurements from the near ultraviolet to the far infrared
- Easy integration into commercial microscopes – small overall dimensions
- Experimental flexibility – may be operated in any orientation and is compatible with the OptistatCF-V cold unit
- 80 K operation – can be used with liquid nitrogen
- Rectangular tail – available in rectangular tail configuration



MicrostatHe dimensions

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Mapping of Quantum Dots

Using the MicrostatHe, Han Htoon, Dmitri Kulik, Hongbin Yu and CK Shih at the University of Texas at Austin have developed a spectroscopic imaging technique capable not only of isolating the spectral features of a single Quantum Dot (QD) but also of locating the exact position of a QD under a micron scale aperture. Their simple and effective technique has now been used to explore both temperature induced carrier transfer and the formation and disintegration of multiple particle states in self assembled quantum dots.

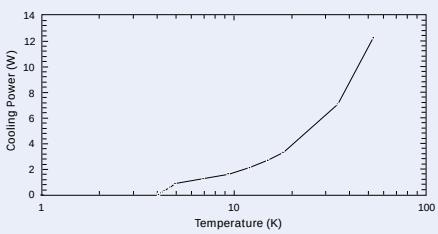
Isolation of the spectral features of a single QD using spectroscopic imaging technique. Spectral images collected using a MicrostatHe at a temperature of 4.3 K

Operation

Through its operational set up the MicrostatHe enables an exceptionally wide temperature range, from 2.2 K to 500 K. A transfer tube links a helium storage dewar to the MicrostatHe cryostat. The MicrostatHe is designed with a small heat exchanger; a low movement sample holder is thermally anchored to the tip of the heat exchanger. Returning helium gas flows along the transfer tube to the exhaust port. The exhaust line is linked to a helium gas flow controller and a small gas flow pump. With the controlled flow of helium, the MicrostatHe cools down quickly (<10 minutes to 4.2 K).

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

The tails of the MicrostatHe are interchangeable for experimental flexibility



Cooling power of the MicrostatHe cooling unit at a flow rate of 2.5 litres of liquid helium per hour.

Optical Performance

The sample holder in the MicrostatHe is adjustable to optimise the cryostat for different samples and different optical configurations. The maximum total angle of acceptance for reflection measurements is 144°.

If the application requires a high power microscope objective, then the working distance from the outside of the cryostat to the sample will limit the choice of lens. The adjustable sample holder may be moved to less than 3 mm from the outer surface of the window. With the sample mounted through the radiation shield aperture, the working distance is limited only by the window thickness and the clearance between the window and both the lens and the sample.

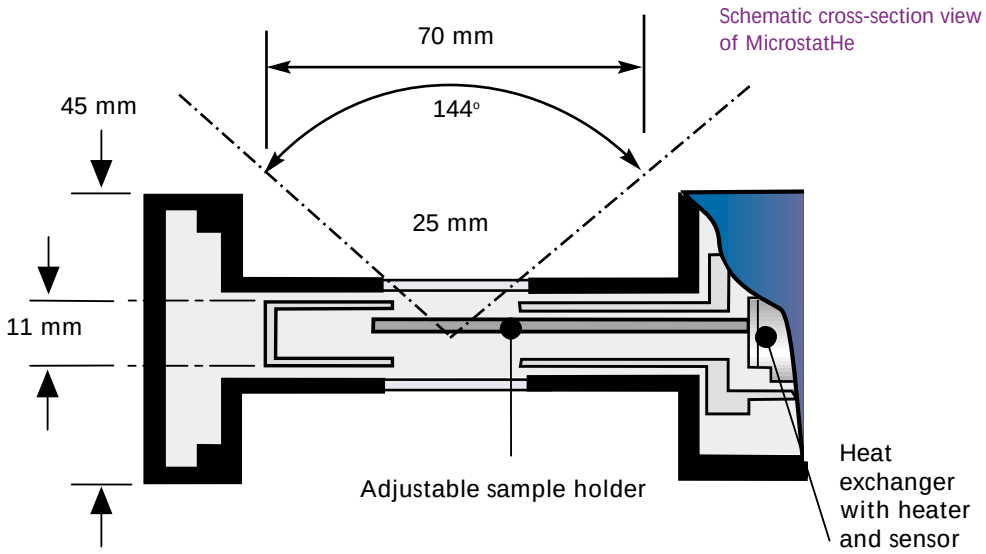
Window options

A number of window options are available for the MicrostatHe. Many customers choose 1.5 mm thick Spectrosil B fused quartz windows. In some applications it is important to reduce the window thickness. A 0.5 mm thick Spectrosil B window is available. However, due to the vacuum forces on the window, a reduction in the thickness requires a corresponding reduction in the aperture. The 0.5 mm window has an aperture of 10 mm diameter.

Thinner window have the following advantages:

- The working distance (from the outside of the cryostat to the sample) is reduced, allowing higher magnification lenses to be used.
- Spherical aberration is minimised.

MicrostatHe Specifications



Schematic cross-section view of MicrostatHe

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	4.5 mm	5.5 mm
Angle of admittance (to surface of sample holder at centre)	102°	144°
Max sample thickness	5 mm	5 mm
Max sample diameter	20 mm	20 mm

All dimensions are approximate and relate to the 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	2.2 K to 500 K (with EPS40 pump) 3.2 K to 500 K (with GF4 pump)
Temperature stability	+/-0.1 K
Helium consumption	<0.45 lhr^{-1} (at 4.2 K)
Cool down time	From ambient to 4.2 K with transfer tube cold = <10 mins
Sample holder drift at constant temperature	+/-1 µm (typical – see note 1)*
Sample holder vibration	0.1 µm (typical – see note 2)*
Sample window material	Spectrosil B fused quartz Other materials available on request
Standard temperature sensor	3 point calibrated rhodium iron (see note 3)
Sample change time	~30 mins (approx)
Weight	1.8 kg

**Approximate measurement. The stability is neither measured nor guaranteed and will be dependent upon the final system's configuration and the environment that the equipment is used in.*

1. Thermal drift of the sample position was measured after the cryostat temperature had stabilised for half an hour at base temperature. At temperatures above 4.2 K the time to reach thermal equilibrium is considerably longer. Typical values for the drift have been measured to be 1 µm in 5 minutes below 100 K and 1 µm in 1 minute above 100 K.

2. Vibration levels were measured with the cryostat, LLT600/13 transfer tube and a diaphragm pump. Room temperature measurements showed that in all directions the displacement due to mechanical vibration for frequencies greater than 500 Hz is negligible. For frequencies below 500 Hz vibration levels are less than 0.1 µm.

3. The cryostat is supplied with a temperature sensor mounted in the heat exchanger. The sample holder is in thermal contact with the heat exchanger. The temperature difference between the sample position and the heat exchanger has been measured to approximately 0.4 K.

System Components

COLDUNIT	Continuous flow cryostat cold unit
MICROTAIL	Tail set for MicrostatHe
VH1	Plain flat sample holder
VH2	Optical sample holder
*OVC** flange	Range of windows mounted in outer vacuum case flange (2 required per tail set)
LLT600/13	Low loss transfer tube with 1.3 m long dewar leg and 1.2 m long transfer tube
GF4	Gas flow pump
VC31	Gas flow controller with helium flow meter
ITC502	Temperature controller
CC1	3 m cryostat cable, 10-pin connector
SV12	Storage vessel adapter
SKHE	Spares kit for MicrostatHe

Standard Options

TRANPLTM2	Mounting plate for transmission measurements (replaces one of the window flanges)
REFLPLTM2	Mounting plate for reflection measurements (replaces one of the window flanges)
MICRORTAIL	Rectangular tail set for MicrostatHe
CFVTAIL	Tail set for Optical CF-V
LLT650/13	Automatic version of the LLT600/13
LX10	10-pin electrical connection wired to terminals above the heat exchanger
CX1	Miniature coaxial connector wired down to the sample holder
HD30	30 litre helium dewar
ITC503	Temperature controller
ITC601RHFE	Temperature controller
ESP40	40 m^3hr^{-1} helium pumping system (for operation down to 2.2 K)
HVP4	High vacuum pumping system
VC41	Gas flow controller with helium and nitrogen flow meters

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