MicrostatHe Rectangular Tail

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Helium, continuous flow optical cryostat

Providing additional flexibility to the MicrostatHe range, the MicrostatHe Rectangular Tail vacuum loading cryostat is specifically designed for magneto-optical measurements requiring temperatures as low as 2.2 K.

Applications

The MicrostatHe Rectangular Tail has been designed with generous optical access for use with the following techniques:

- Magneto-optical Kerr effect measurements (polar, longitudinal and transverse effect measurements).
- Faraday effect measurements
- Magneto-optical imaging

The last few years have seen increased research interest in layered and nano-structured magnetic materials, which have a wide range of potential future applications. In studying such materials, Kerr effect measurements provide the researcher with a method for the fast, low cost measurement of magnetic hysteresis loops. The benefits of using a low temperature Kerr effect system include:

- Ability to study magnetic phase transitions
- Ability to study the temperature dependence of the Kerr effect
- Spin lifetimes are longer at low temperatures facilitating time-dependent measurements
- Signals are stronger at low temperatures

Components

The MicrostatHe Rectangular Tail system consists of:

- MicrostatHe Rectangular Tail 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 only)
- Gas flow controller

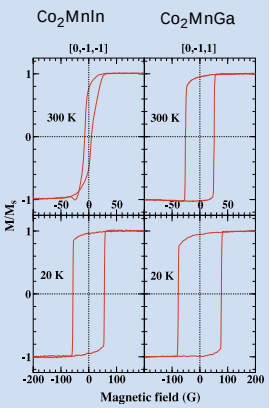
Features and benefits

- 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. Helium consumption less than 0.45 lhr^{-1} at 4.2 K
- Optical access in two perpendicular directions – allowing angular dependent studies, constant angle studies at an optimal angle, as well as glancing angle studies
- Adjustable sample holder – to maximise optical access irrespective of sample thickness
- Compact overall size – for easy integration with a range of electromagnets and/or Helmholtz coils
- Experimental flexibility – may be operated in any orientation and its cold unit is compatible with both the MicrostatHe and the OptistatCF-V tails (from our wider Optistat range of optical cryostats).

OXFORD INSTRUMENTS

Heusler alloys for Spin-injection Devices

S. Holmes and M. Pepper from the Cambridge Research Laboratory at Toshiba Research Europe have used a MicrostatHe Rectangular Tail to help them elucidate the electrical and magnetic properties of cobalt-based Heusler alloys. This group of magnetic materials are ideal half-metallic materials for spin-injection in nanostructured semiconductor devices. At temperatures of 300 K the research group has demonstrated that these Co-based alloys are ferromagnetic with controllable magnetic and electrical properties. Co_2MnGa, for example, displays metallic rather than semiconducting behaviour over a range of wafer thicknesses. Furthermore, an anisotropic magnetoresistance of 6% at 300 K demonstrates the importance of spin-orbit scattering of these disordered alloys, indicating their potential for use for more conventional computing-based devices.



MOKE loops for $C0_2MnIn$:GaAs(001) and $C0_2MnGa$:GaAs(001) for the in-plane field orientations along [0,-1,1] and [0,-1,-1]

Operation

The MicrostatHe Rectangular Tail requires a slightly more complex set up than the MicrostatN to enable its exceptionally wide temperature range, from as low as 2.2 K to 500 K. A transfer tube links a helium storage dewar to the cryostat. The MicrostatHe Rectangular Tail 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 cryostat cools down quickly (<10 minutes to 4.2 K).

Temperatures below 4.2 K are achieved by lowering the helium vapour 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.

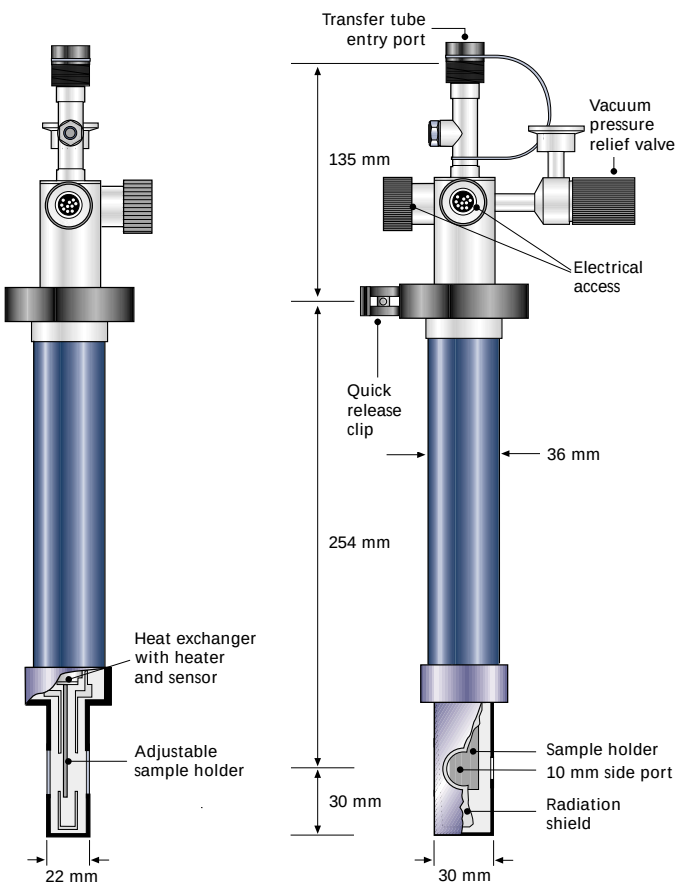
Optical Performance

The sample holder in the MicrostatHe Rectangular Tail is adjustable to optimise the optical access of the cryostat for different sample thickness. The maximum total angle of acceptance for reflection measurements is 55° from normal, allowing Kerr effect measurements to be made at the optimal angle for most samples. In transmission, the sample may be positioned to accommodate both incident and transmitted light over an angle of 85°.

Window options

The MicrostatHe Rectangular Tail provides four optical access ports fitted with Spectrosil B windows as standard. Alternative materials can be supplied on request.

MicrostatHe Rectangular Tails dimensions

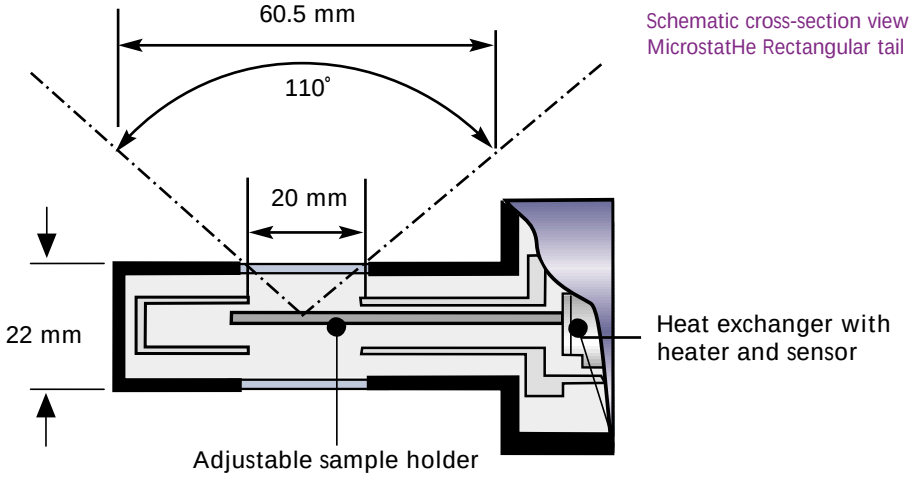


Experimental flexibility

The tail of the MicrostatHe Rectangular Tail is interchangeable with that of the standard MicrostatHe and the OptistatCF-V. These cryostats are typically used for UV/Vis, IR, Raman or photoluminescence spectroscopy, expanding the versatility of the system.

The tails of the MicrostatHe are interchangeable for experimental flexibility

MicrostatHe Rectangular Tail Specifications



Schematic cross-section view of MicrostatHe Rectangular tail

Optical specifications	Window thickness 1.0 mm
Clear access diameter	20 mm
Sample holder to window top surface	8 mm
Angle of admittance (to surface of sample holder at centre	110°
Max sample thickness	4 mm
Max sample diameter	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) 80 K to 500 K (with liquid nitrogen operation)
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	1.6 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
MICRORTAIL	Rectangular Tail set for MicrostatHe
VH1	Plain flat sample holder
VH2	Optical sample holder
LLT600/13	Low loss transfer tube with 1.3 m long dewar leg and 1.2 m length flexible section
GF4	Gas flow pump
VC31	Gas flow controller with helium flow meter
ITC503/ITC502	Temperature controller
CC1	3 m cryostat cable, 10-pin connector
SV12	Storage vessel adapter
SKHE	Spares kit for MicrostatHe

Standard Options

CFVTAIL	Tail set for OptistatCF-V
LLT650/13	Automatic version of the LLT600/13
LX10	10-pin electrical seal wired to terminals above the heat exchanger
CX1	Miniature coaxial connector wired down to the sample holder
HD30	30 litre helium dewar
ITC601RHFE	Temperature controller
ESP40	40 m^3hr^{-1} helium pumping system (for operation at 2.2 K)
HVP4	High vacuum pumping system
VC41	Gas flow controller with helium and nitrogen flow meters

Oxford Instruments Superconductivity

UK
Tubney Woods, Abingdon
Oxfordshire OX13 5QX
Tel: +44 (0)1865 393 200
Fax: +44 (0)1865 393 333

China
Rm. 14-F, No.1 Plaza
No.800 Nanjing East Road
Shanghai 200001
Tel: +86 21 63608530/1/2/3
Fax: +86 21 63608535

Germany
Otto-von Guericke Ring 10
D-65205 Wiesbaden
Tel: +49 6122 937 171
Fax: +49 6122 937 175

Italy
Via Leone Tolstoi 86
20098 San Giuliano
Milanese
Milan
Tel: +39 02 98 2215
Fax: +39 02 98 2414

Japan
Haseman Building
2-11-6 Tomioka, Koto-ku
Tokyo 135-0047
Tel: +81 03 5245 3261
Fax: +81 03 5245 4472

Spain
Avda Mata Piñonera, 2
28700 San Sebastian de los Reyes
Madrid
Tel: +34 91 659 0740
Fax: +34 91 654 6794

U.S.A.
130A Baker Ave. Ext.
Concord, MA 01742-2121
Tel: +1 978 369 9933
Fax: +1 978 369 6616

E-mail:
superconductivity@oxinst.co.uk

Visit our web site at
www.oxford-instruments.com

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