BL43IR Infrared Materials Science

This beamline covers a wide wavenumber region from 100 cm^{-1} to 20,000 cm^{-1} and is exclusively dedicated to infrared spectroscopy. Four kinds of experimental stations were constructed to perform various kinds of experiments which are difficult to perform with conventional black body sources. The beamline has four experimental stations: Infrared microspectroscopy station; Surface science station; Absorption & reflection spectroscopy station with synchronized laser system; and Magneto-optical spectroscopy station.

Area of research

Infrared microspectroscopy
Magneto-optical spectroscopy
Infrared surface science
Absorption and reflection spectroscopy
Time-resolved experiments with pulsed laser and SR (pump and probe)

Keywords

Scientific field

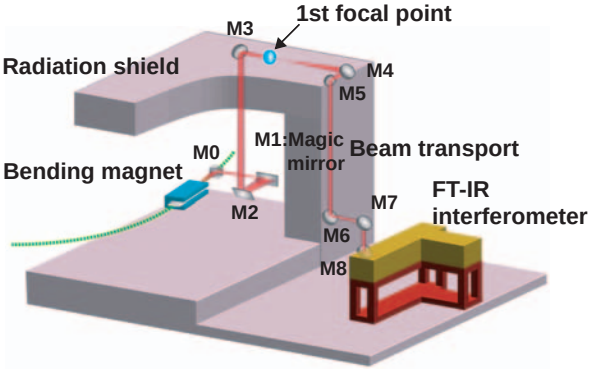
Solid state physics, Industrial research, Surface science, Geochemistry, Medical science

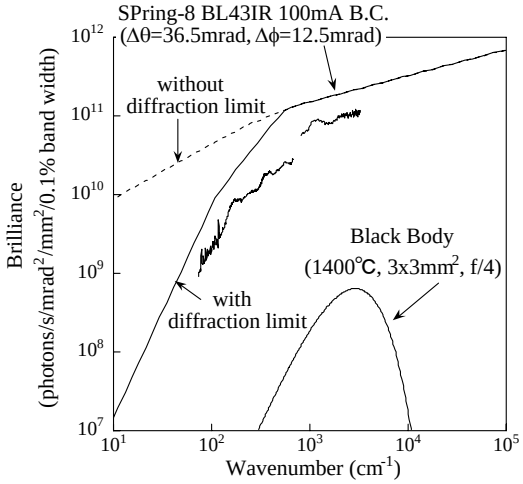
Equipment

Microspectroscopy, Magneto-optical spectroscopy, Infrared reflection absorption spectroscopy, Pump and probe measurement

Source and optics

Frontend



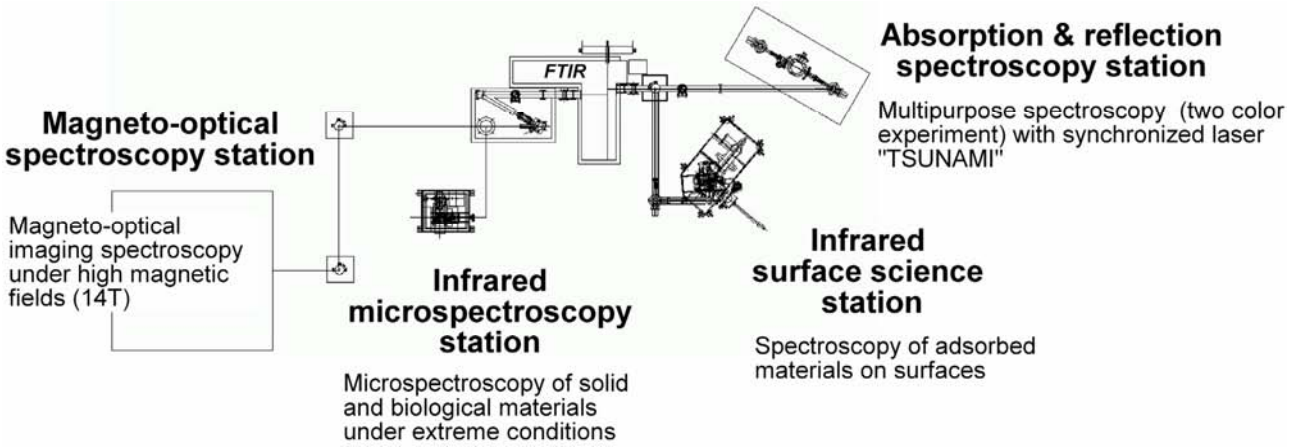


Brilliance

The key features of infrared synchrotron radiation are high brilliance in the entire wavenumber region and high total photon flux in the far-infrared region. The brilliance of our beamline is more than 100 times stronger than that of black body source. The observed brilliance is close to the simulated one.

Bruker IFS120HRX FTIR

1. Wavenumber range : 100 ~ 20,000 cm^{-1}
2. Beam splitter : Quartz, Ge/KBr, Mylar (3.5 and 6 μm)
3. Internal light source : Globar, W-halogen
4. Internal detector : Si diode, Ge diode, MCT, DTGS (far IR)
5. Maximum wavenumber resolution : 0.0063 cm^{-1}



Experimental stations

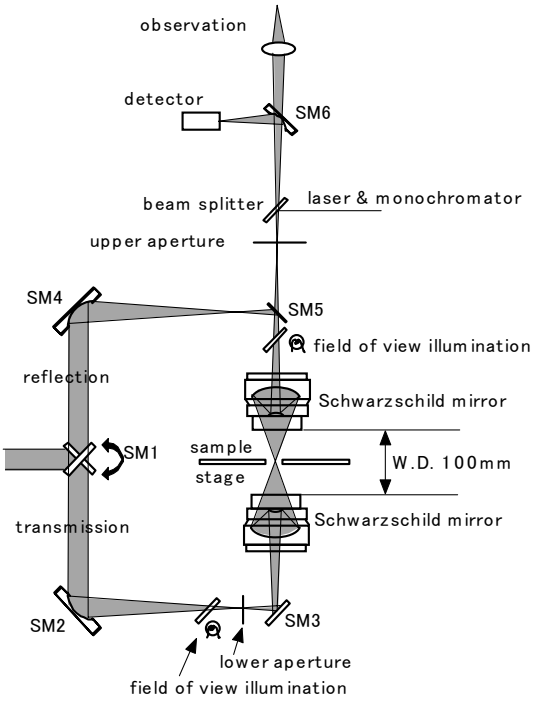
Infrared microspectroscopy station

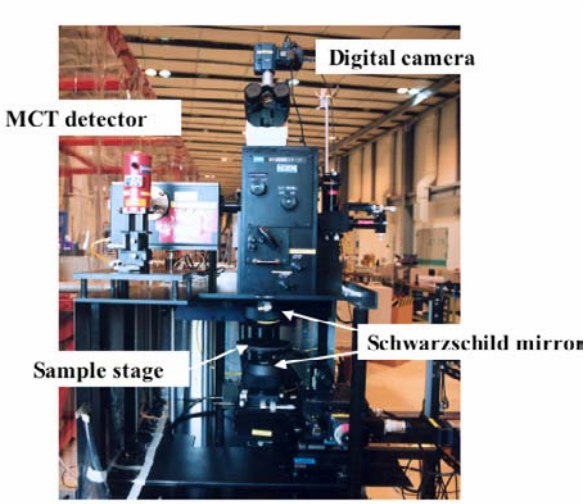
The infrared microscope of BL43IR performs microanalysis of various specimens as small as 10 μm diameter with the use of an infrared synchrotron radiation which is highly collimated and highly brighter than the conventional IR light source.

1. Wide wavenumber region (100 ~ 20,000 cm^{-1})
2. Polarizer covers the entire wavenumber region
3. The spatial resolutions are 10 μm without an aperture in mid-IR.With an aperture, 5 μm is minimum resolution in mid-IR.In far-IR, the resolution reaches the diffraction limit.
4. Transmission and reflection measurements
5. Long working distance (100 mm (± 50 mm)) between Schwarzschild mirrors (× 8, NA = 0.5)
6. In-situ measurement of ruby fluorescence for DAC study
7. All optical paths possible to be purged with dry air.

Sample stages and accessories for microspectroscopy station

- X-Y-Z motor-controlled stage
  Working length: X-Y : 100 mm, Z : 10 mm, Minimum step : 1 μm (micron)
- Bruker X-Y mapping stage
  Working length : X-Y 100 mm
  Minimum step : 1 μm (micron)
- Flow-type cryostat
  Microstat-He : Oxford Instruments Co. Ltd.
  Temperature: 4.2 ~ 400 K, Window: Quartz, KRS-5, BaF_2, polyethylene
- Low temperature DAC
  Gas-membrane type DAC : ~20 GPa @ 0.6 mm curette size
  Temperature : 10 ~ 400 K, Window : Quartz, KRS-5, BaF_2, polyethylene
- High temperature DAC
  Lever type, external heating HTDAC (~700°C, ~30 GPa)
  Sample stages can be synchronized with FTIR to measure 2D mapping spectrum.

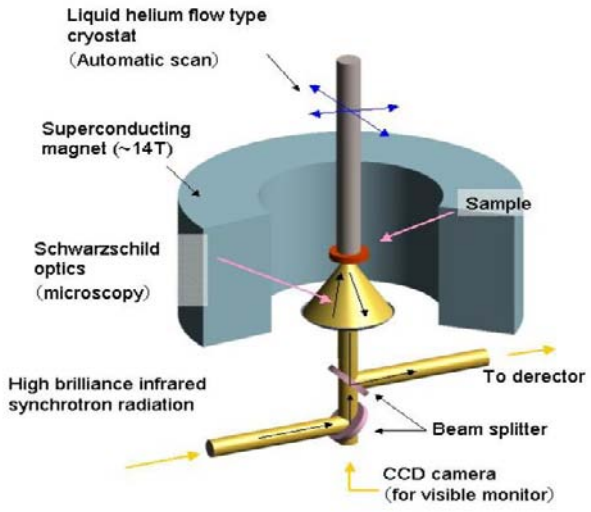


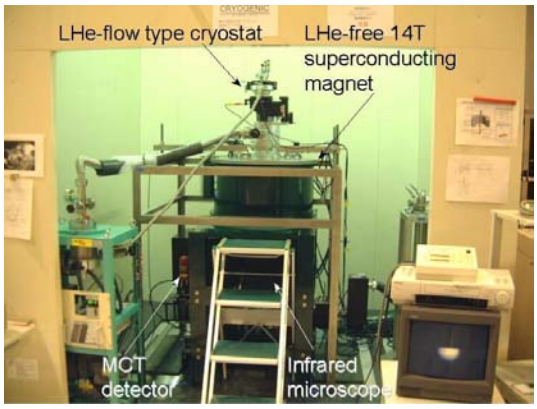


Magneto-optical spectroscopy station

The magneto-optical spectroscopy station is offered to the investigation of the magneto-optical properties of solids in the low energy region under a high magnetic field up to 14 T. Particularly, the infrared magneto-optical imaging spectroscopy which combined the microspectroscopy with the magnetic field is available. The purpose is to investigate the electronic structure of minute materials such as organic conductors and of minute region like magnetic domains.

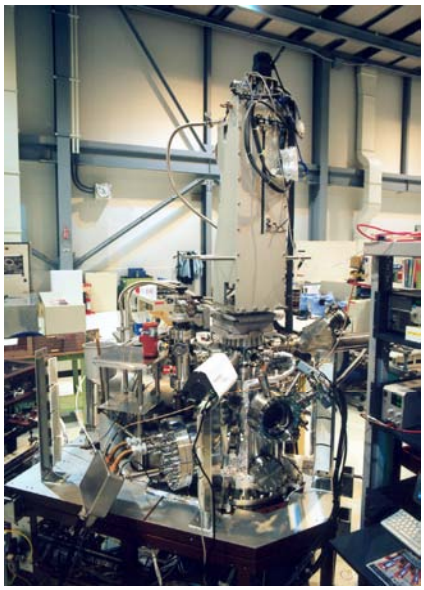
Maximum magnetic field	14 T
Minimum temperature of sample	3.7 K
Spatial resolution	10 μm (without aperture)
Wavenumber range	700 ~ 7000 cm^{-1}
Polarization	Linear / Elliptic





Infrared Surface Science Station

The Surface Science Station at BL43IR employs Infrared Reflection Absorption Spectroscopy (IRAS) which is widely recognized as one of the most powerful methods to study surface adsorption of molecules on the surface.



Sample holders

1. Conveyable type with which the samples can be introduced in-situ from a load-lock inlet to the preparation and measurement chambers. The temperature of the sample is adjustable between -140 and 900°C.
2. Fixed type with which a metal single crystal is secured on the holder. The temperature range is between -250 and 1000°C.

Attached equipment

1. Low Energy Electron Diffraction / Auger Electron Spectrometer (LEED/AES: Omicron SPECTALEED)
2. Quadrupole Mass Spectrometer (QMS: Balzers QMS200)
3. Leak valve, Pulsed valve, K-cell evaporator

Absorption & reflection spectroscopy station

The absorption & reflection spectroscopy station offers the possibility of performing time-resolved IR spectroscopies with sub-nano second to micro second time resolutions, in addition to conventional absorption and reflection spectroscopies of small samples. The station is equipped with a picosecond pulsed Ti:Sapphire laser system, a closed-cycle refrigerator, and an UHV sample chamber that has many windows for easy optical accesses. These features enable pump-probe IR spectroscopies (laser-pump, IR-probe) of various materials in wide ranges of temperature and wavelength.

Equipment

1. Picosecond mode-locked Ti:Sapphire laser system (Spectra Physics Tsunami 3950-LTC) excited by a solid state CW green laser (Millenia VP)
   Wavelength tunable over 720 ~ 900 nm (fundamental)
   SHG also available with 3980-3S-LTC frequency doubler
   Pulse width: 1 ~ 3 psec
   Average output power: > 1 W @ peak (5 W TEM00 excitation)
   Repetition rate: 84.8 MHz (synchronized to 1/6 of the SPring-8 standard RF frequency of 508.6 MHz)
   A pulse picker (selector) available: 4 MHz to single shots
2. UHV-compatible sample chamber (a "6-way cube". Different flanges can be adapted easily for different experiments.)
3. Closed-cycle refrigerator (Iwatani M310 "Cryo-Mini". Variable temperature control over 5.5 ~ 450 K range.)

Detectors

- Hamamatsu Si photodiode S1337-1010BR
- EG&G Judson InSb J10D-M204-R01M-60 element size ϕ 1mm sapphire window
- EG&G Judson MCT J15D24-M204-S02M-60 element size 2 × 2 mm^2 KRS-5 window
- Infrared Associates MCT MCT-13-0.25-MSL12-ZnSeW element size 0.25 × 0.25 mm^2 ZnSe window
- Infrared Laboratory 4.2 K Si Bolometers with HDL-8 and HDL-5 dewers

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