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The IRIS THz/Infrared beamline at BESSY II

Helmholtz-Zentrum Berlin für Materialien und Energie *

Instrument Scientists:
- Dr. Ljiljana Puskar, Helmholtz-Zentrum Berlin für Materialien und Energie
  phone: +49 30 8062-14739, email: ljiljana.puskar@helmholtz-berlin.de
- Dr. Ulrich Schade, Helmholtz-Zentrum Berlin für Materialien und Energie
  phone: +49 30 8062-13449, email: ulrich.schade@helmholtz-berlin.de

Abstract: At BESSY II a large acceptance angle, multipurpose infrared beamline is available, comprising several end stations suitable for material and life science investigations. The beamline provides highly brilliant infrared radiation over the energy range from about 20,000 down to 30 cm^{-1} and even lower when BESSY II is run in the so-called low-α mode.

1 Introduction

Infrared radiation from synchrotron sources has seen a steady increase in research over the last decade. At synchrotron light sources of third generation like BESSY II the emitted radiation in the infrared wavelength region is some orders of magnitude brighter than standard thermal broadband sources (e.g., globar). In addition, infrared synchrotron radiation is an absolute source being polarized and pulsed in the picosecond timescale. As a particular specialty, BESSY II provides a new technique (low-α) to generate high power, stable and low-noise coherent terahertz (THz) radiation (Abo-Bakr et al., 2003). The IRIS beamline was inaugurated in December 2001 (Schade et al., 2002) and is now used by a multi-disciplinary research community.

2 Optical Design

The beamline uses radiation from the homogenous magnetic field (Schade et al., 2000) of the dipole D11 and its optical layout (Peatman & Schade, 2001) is shown in Figure 1. A plane extraction mirror is placed at about 900 mm from the dipole source in the plane of the storage ring allowing horizontal and vertical acceptance angles of about 60 x 40 $mrad^2$, respectively. The mirror is split into two water-cooled halves positioned above and below the narrow high energy radiation fan in the ring plane, permitting most of

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the heat due to UV and X-rays to pass through to an absorber. The extraction mirror deflects the beam upwards to a combination of two cylindrical mirrors. These mirrors then focus the beam outside the radiation shielding of the ceiling of the storage ring tunnel just behind a CVD diamond window. The diamond window separates the UHV of the storage ring from the vacuum system of the remainder of the beam line. The subsequent optical elements direct the light to the different experiments. In addition, an ellipsometer (Gensch et al., 2006) is attached to a vacuum FT-IR spectrometer.

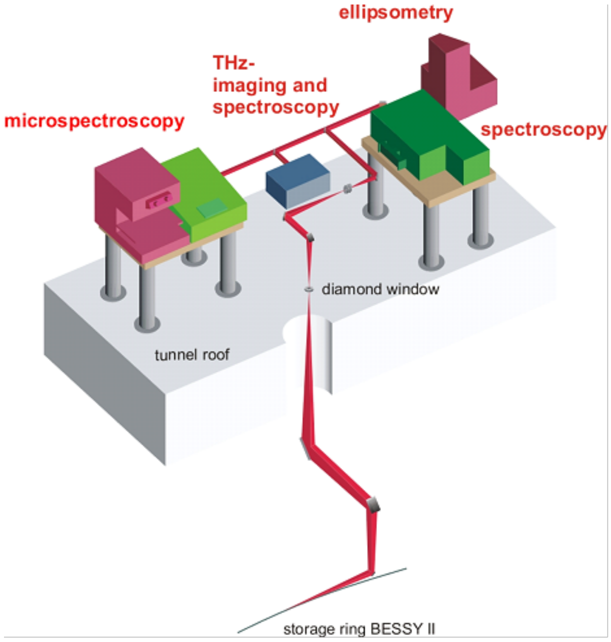

Figure 1: Schematic of the optical layout of the IRIS beamline.

3 Beamline Performance

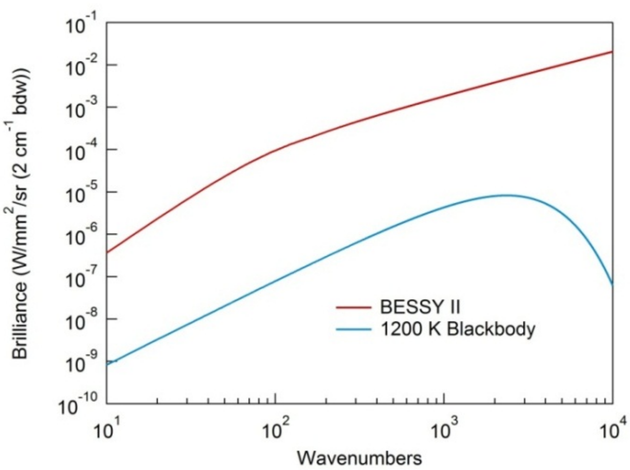

Figure 2: Calculated brilliance in the infrared spectral range for the IRIS beamline at BESSY II and for a globar source.

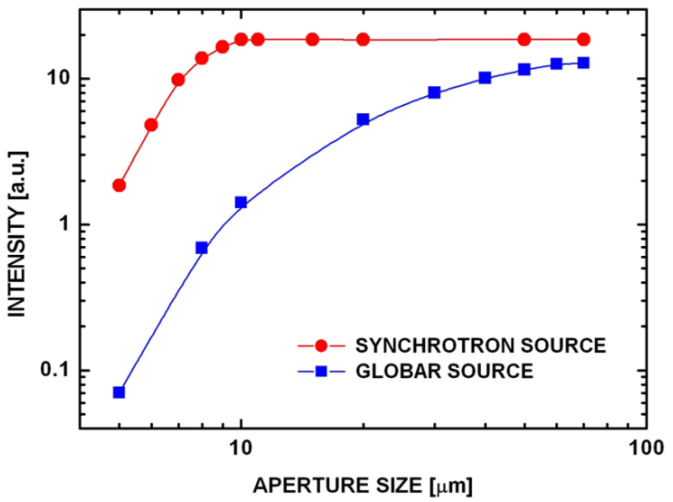

Figure 3: In the mid infrared range, more than one order of magnitude more flux can be fed through apertures smaller than 10 x 10 μm^2 when compared to a globar source. This allows one to perform diffraction-limited microspectroscopy. Data were taken with a Nicolet Continuμm infrared microscope in confocal transmission geometry using the internal instrument aperture with no sample in the focal plane.

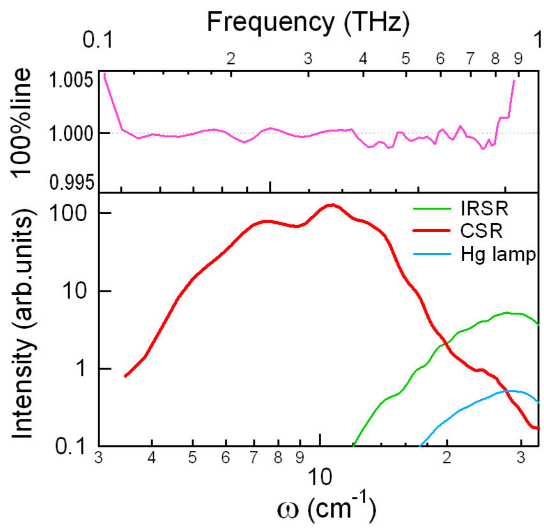

Figure 4: Comparison of fluxes in the far IR/THz range. Running BESSY II in the low-α mode yields coherent synchrotron radiation (CSR) at the IRIS beamline with fluxes several orders of magnitudes higher than obtained with incoherent infrared synchrotron radiation (IRSR) or with internal spectrometer sources (Hg lamp). An rms noise of better than 0.1% is achieved from the CSR source as indicated by the 100% line, the ratio of two subsequently recorded spectra. Data were taken in vacuum using a Bruker 66/v spectrometer (Schade et al., 2007).

4 Experimental Stations

- Vacuum FT-IR Spectrometer NIR, MIR, FIR
- Ellipsometer (operated by ISAS) MIR
- Martin-Pupplet Spectrometer FIR (THz)
- Near-field Microscope FIR (THz)
- Scanning Microscope MIR
- Vacuum Microscope FIR (THz), MIR

Samples can be investigated with different polarization states of the light under several geometries (e.g., transmittance, grazing and normal incidence reflectance, diffuse reflectance, ATR) and for different environmental conditions, like pressure and temperature.

5 Technical Data

Location	3.1
Source	D11
Energy Range	2 – 10,000 cm^{-1}
Horizontal Source Acceptance	60 mrad
Vertical Source Acceptance	40 mrad
Polarisation	- linearly horizontal/vertical - circularly left and right handed
Spectrometer	Fourier Transform Spectrometer
Energy Resolution	0.125 cm^{-1}
Focus Size at Sample	diffraction limited
Free Photon Beam available	yes
Fixed End Station	microscopes, spectrometers, ellipsometer

Table 1: Technical data of the IRIS Beamline.

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