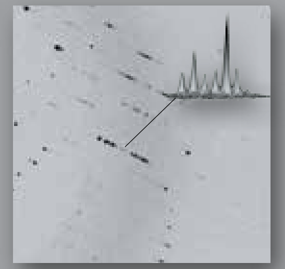
… – the options are endless

IµS for Chemical Crystallography

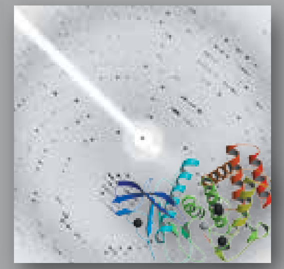
- Cu, Mo and Ag anode
- dedicated optics for X-ray analysis of powders and single crystals
- integrated into Bruker AXS equipment for chemical crystallography
- can be combined with all modern 2-dim detectors
- structure determination of single crystals and powders
- charge density studies
- high-pressure crystallography

IµS for Protein Crystallography

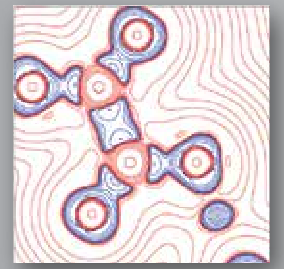
- flux density above traditional 5 kW-class rotating anodes
- dedicated optics for low divergence and very small samples below 100 µm
- integrated into Bruker AXS equipment for biological crystallography
- lowest maintenance & highest convenience
- replacement for 5 kW-class rotating anodes, fully integrated into your image plate or CCD system
- protein structure determination
- SAD (single wavelength anomalous dispersion) phasing
- protein screening



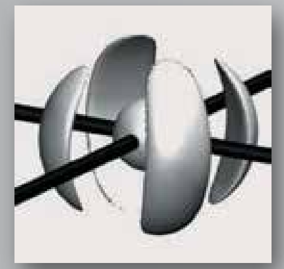
Resolving a 202 Å cell axis with a Cu-IµS MX (by H. M. Holden, Madison).



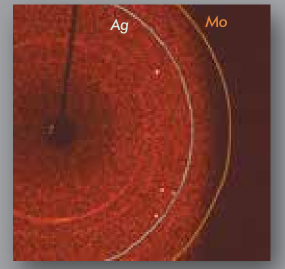
Typical diffraction pattern and structure model of Thermolysin (by A. Heine, Marburg).



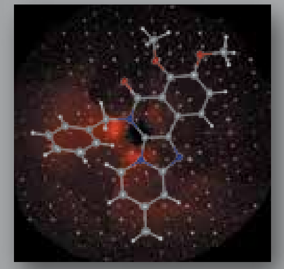
Laplacian of the electron density of Oxalic Acid (by C. W. Lehmann, Mülheim).



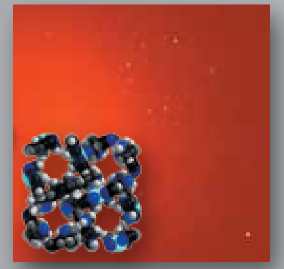
Laplacian of the electron density at the Co atom in $Sc_3Co(C_2)_2$ (by W. Scherer, Augsburg).



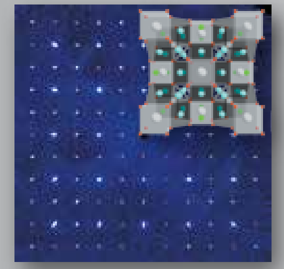
Diffraction pattern of a Gabapentin crystal in a diamond anvil cell (by F. P. A. Fabbiani, Göttingen).



Simulated precession pattern and molecular structure of an isoquinoline (by D. Stalke, Göttingen).



Diffraction pattern and molecular structure of a MOF compound (by R. W. Seidel, Mülheim).



Simulated precession pattern of the mineral Murdochite $PbCu_6O_7(Cl,Br)_2$.

Your partner for X-ray optics and microfocus sources!

History of IµS

History of IµS

1995 Beginning of multilayer X-ray optics development at GKSS Research Centre

2001 2-dim beam shaping with Montel Optics

2002 Foundation of Incoatec

2006 Launch of Cu-IµS for biological crystallography and small-angle scattering

2007 1st Cu-IµS installed at the Center for Structural Biology, Kiel, Germany

2007 Mo-IµS developed for chemical crystallography

2008 New Helios MX Optics for IµS and rotating anodes for protein crystallography

2009 1st Ag-IµS installed at the Institute of Inorganic Chemistry, Göttingen, Germany

2010 100th IµS installed at the Fédération Chevreul (CNRS) in Lille, France

2011 Launch of the IµS High-Brilliance

For more information on Incoatec and our microfocus solutions please contact us at:
sales@incoatec.de or visit our website at www.incoatec.de

Incoatec – Your Partner for X-ray Optics and Microfocus Sources: Incoatec was incorporated in 2002 by former members of the GKSS Research Centre in Geesthacht near Hamburg and the Bruker AXS GmbH. We have a long history in the development of X-ray optics based on thin film technology. Incoatec manufactures all products on-site - Made in Germany. Our Optics are used in X-ray diffractometry, spectrometry and at synchrotron beamlines all over the world. Our microfocus source IµS sets new standards in home-lab X-ray analytics.

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INCOATEC
innovative coating technologies gmbh

IµS – Incoatec Microfocus Source

INCOATEC
innovative coating technologies gmbh

OFTEN COPIED – NEVER EQUALLED

- Sealed Tube – stable and highly brilliant
- Air-cooled – ecological and reliable
- Focusing / Collimating – high-end 2-dim Multilayer Optics
- Light & Small – easily installed to a diffractometer
- Maintenance free – sustainable with low cost of ownership

IµS Applications – …

IµS meets your requirements

The Incoatec Microfocus Source IµS is available in different configurations for protein crystallography, chemical crystallography, small-angle scattering and material research. It combines the superb performance exceeding that of the traditional 5 kW-class rotating anode sources with the easy handling of sealed tube systems. The IµS is available with Cu, Mo, Ag and Cr radiation. The X-rays can be focused as well as collimated. The beam size depends on the optics properties and the geometry of the experiment. It is generally in the range of 50 to 500 µm at the sample position. Main applications are illustrated below. Further results from our application lab are available as application notes. Our customers' publications give a closer insight into the amazing possibilities of the IµS. The latest results can be downloaded from our website.

IµS for Small-Angle Scattering SAXS

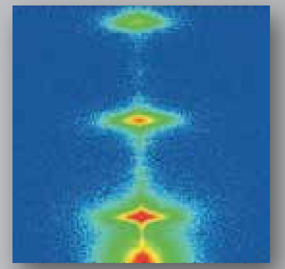
- Cu anode
- integrated into Bruker AXS Nanostar
- collimated beam with 0.5-1 mrad divergence
- high performance SAXS and GISAXS in the lab
- ideal for customized systems
- approver for the latest detector technology
- suited for solid as well as liquid samples
- in-situ measurement of nano-ordering possible

IµS for X-ray Diffraction

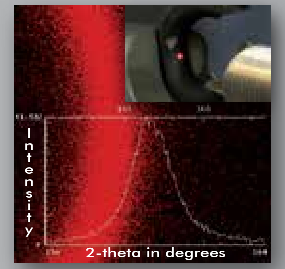
- Cu, Mo, Cr anode
- combined with all modern detectors
- integrated into the Bruker AXS D8 Discover

for the following applications:

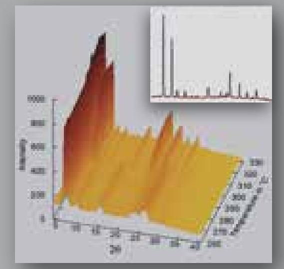
- powder diffraction
- stress analysis
- reflectometry
- texture measurements
- micro-diffraction
- surface diffraction
- PDF (pair distribution function)
- semiconductor industry (Bruker AXS Fabline)



GISAXS of a Mo/Si multilayer with a Bruker Nanostar with Cu-IµS (by P. Šiffalovič, Bratislava)

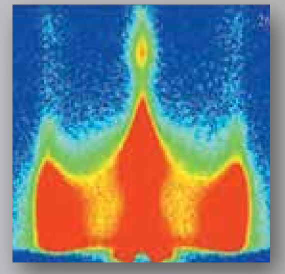


Stress determination of a steel part with a Cr-IµS on a Bruker GADDS (by H. Göbel, München)



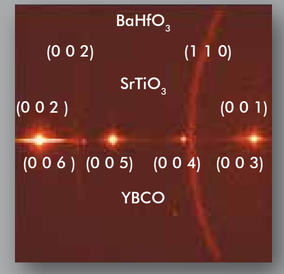
Diffraction pattern and profile fitting of Cu phthalocyanine measured with Cu-IµS and imaging plate detector

Diffraction pattern of a $CaCO_3$-cuttlebone measured with Mo-IµS and imaging plate detector



GISAXS of silver nanoparticles on a Langmuir film measured with Cu-IµS and Dectris detector by P. Šiffalovič

Pole figure of a brass sheet measured with Cu-IµS on a Bruker GADDS system



Measurement of textured $BaHfO_3$ nanoparticles deposited on YBCO with a Cu-IµS on a Bruker GADDS system

Diffraction pattern of LaB_6 measured with Mo-IµS and a Mar imaging plate detector

Manufacturing & Technology

The IμS is a high-brilliant microfocus source which consists of a sealed tube, a multilayer optics and a high voltage generator. The production and assembly of all key components are carried out in-house.

The IμS is equipped with the latest generation of Montel Optics, the so-called Quazar Optics, which can be up to 15 cm in length. The coating of these multilayer optics is produced using the highly reliable and precise method of magnetron sputtering. With various types of sputtering systems different sizes of substrates ensure a cost-effective production (fig 1). The plasma inside the high-vacuum chamber (fig 2) enables the deposition of single layers in the sub-nanometer range down to a precision of 0.2%. The high quality of multilayer structure is displayed in the transmission electron microscopy image of a standard multilayer (fig 3). To maintain a high standard in quality all optics are measured at several positions with X-ray reflectometry. Figure 4 shows the reflectometer with which standard measurements (fig 5) are carried out. The film thickness can be calculated from the position of the first Bragg peak. Figure 6 shows the thickness of a multilayer pair along the length of the substrate and displays the allowed range of deviation for a Quazar Optics. In the next step the multilayer optics are mounted and pre-aligned in our patented optics housing garantueeing high stability (fig 7).

The microfocus source consists of two parts: firstly an X-ray tube mounted and aligned inside the cooling body and secondly an upper housing part containing the fans, the electronic controls and the safety shutter system. Figure 8 shows how these two parts are assembled. Due to the low weight it is possible to mount the IμS on all kinds of standard goniometers and positioning stages, making a customer-specific integration into existing setups possible. This type of installation has been carried out successfully for numerous customers.
For the electronic control of the IμS an intelligent X-ray generator has been developed that is also produced in-house (fig 9). From the first IμS model on, we have implemented a sensor inside the optics housing that closes the shutter if the multilayer is not used in vacuum (the brilliant X-ray beam would otherwise destroy the optics by producing ozone). Our new IμS High-Brilliance is even more advanced as the generator collects additional information on the properties of the tube and the optics. Additionally, parameters such as the ramp rate of the tube or system failures are monitored. This monitoring system ensures a better and faster customer support. Furthermore, for safety reasons the shutter between source and optics can only be opened if the optics housing is mounted correctly. Customer-specific wishes such as individual safety circuits or motorized optics alignment are fulfilled by our experienced electronics group.

After manufacturing every IμS is tested in our X-ray lab (fig 10). The beam profile is measured with a calibrated detector and the intensity of the beam is checked and recorded. This value is the benchmark which needs to be achieved at the customer's site after the IμS has been installed. Our complete production chain ensures that every single IμS is most accurately manufactured and characterized before leaving our company. Our in-house development is a guarantee for the customer that the IμS product range is continuously being improved and special customer requirements are met quickly at a good price performance ratio.


fig 1

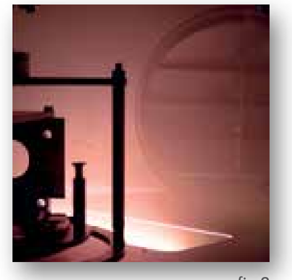


fig 2


fig 3

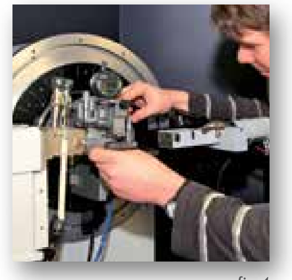


fig 4

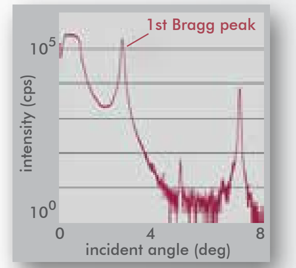


fig 5

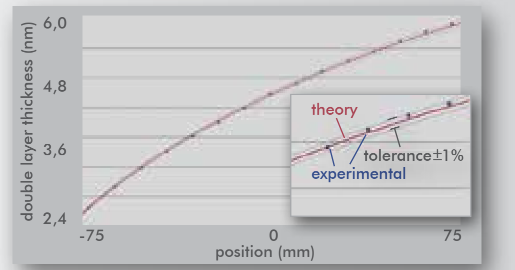


fig 6


fig 7

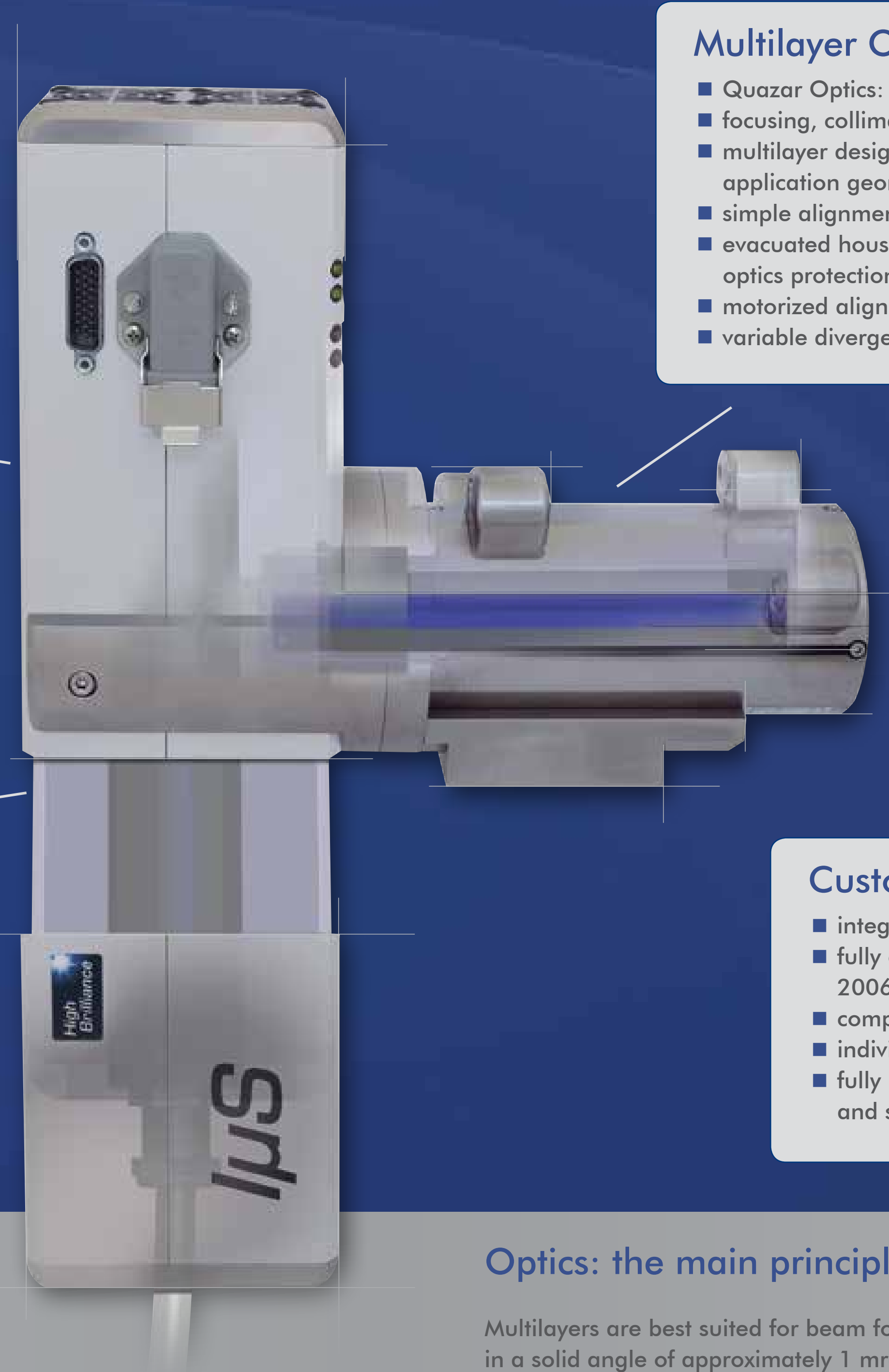

fig 8


fig 9


fig 10

The Microfocus Source

IμS inside:



Tube Housing

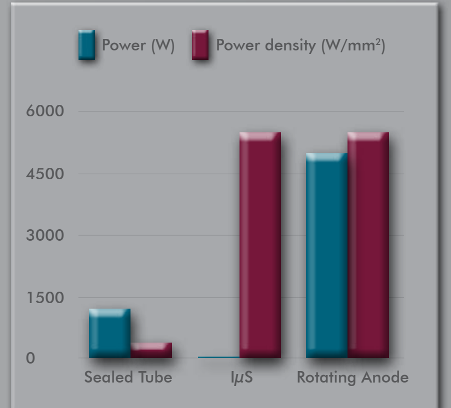
- high-performance air-cooling
- new shutter with optoelectronical monitoring for longer life-time
- labelled LEDs for the sake of clarity

X-ray Tube

- sealed tube
- microfocus spot at anode (< 40 μm)
- easy replacement
- wavelength: Cu, Mo, Ag or Cr
- long life-time >> 3y

Tube: the main principle

The IμS provides a highly brilliant X-ray beam in a power range of 10-50 W. It reaches an amazing performance by using air-cooling and a low-power sealed tube. The IμS is a microfocus source as the focal spot of the electron beam on the anode only has a diameter of 20-50 μm. Incoatec offers all typical anode materials like Cu, Mo, Ag and Cr.
Due to the higher surface-to-volume ratio of the focal spot compared to the old 1-2 kW sealed tubes, the IμS has an improved heat conductivity and thus allows significantly increased power densities. With values larger than 5 kW/mm² the performance of the IμS is comparable to 5 kW-class rotating anodes (see graphic).
The brilliance cannot be increased by the optics, therefore it is of utmost importance to achieve the highest possible brilliance within the tube. Consequently, it is best to combine the tube with a multilayer optics as opposed to other types of optics, as this ensures that the small focal spot is directed to the sample with the highest possible brilliance conservation.



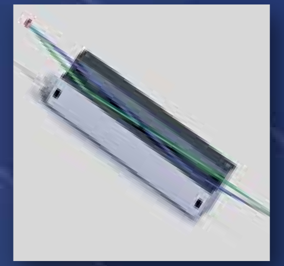
The Optics

Multilayer Optics

- Quazar Optics: Montel type 2-dim beam shaping
- focusing, collimating or hybrid
- multilayer design optimized for source properties and application geometry
- simple alignment & stable position
- evacuated housing for minimal air-scattering & maximal optics protection
- motorized alignment (optional)
- variable divergence slit (optional)

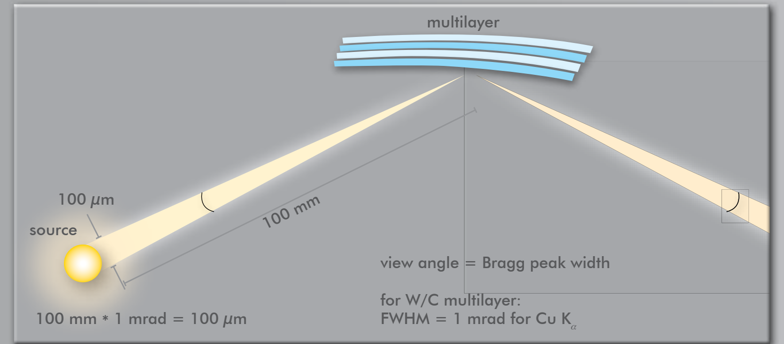
Customized Engineering

- integration in all common safety circuits
- fully compliant with Machinery Directive 2006/42/EC
- component recognition available
- individual mechanical adaptation
- fully implemented into Bruker AXS software and safety system



Optics: the main principle

Multilayers are best suited for beam formation and monochromatization of X-rays. Applying Bragg's law X-rays are collected in a solid angle of approximately 1 mrad e.g. at W/C multilayers and are redirected with a reflectivity larger than 80 % while simultaneously suppressing K_β-radiation. To take account for the varying incident angles, the multilayer requires a lateral gradient of the layer thickness. It is possible to focus the incident beam with an elliptically shaped substrate. A collimation is achieved with a parabolically shaped substrate. A 2-dim shaping of the beam is possible by combining and fixing two multilayer mirrors side-by-side in an L-shape. This assembly is called Montel optics. In this geometry the beams are doubly reflected and thus the monochromatization effect is squared.
The graphic illustrates that the multilayer optics are an ideal combination for X-ray sources with a focal spot diameter well below 100 μm on the anode. With larger sources the range of incident angles increases. Therefore, the multilayer optics can only reflect the incident beam partially as the other X-rays do not fulfil Bragg's law. Generally, the optics can be designed to meet customer's needs. Hence, there are optics exhibiting e.g. low divergencies or high flux densities with spots on the sample varying from some 10 μm up to the mm range.



Installations

Integration into complete systems

- for single crystal diffractometry
- for material science
- for small-angle scattering (SAXS)


Bruker AXS X8 PROSPECTOR


Bruker AXS D8 DISCOVER


Bruker AXS D8 VENTURE

Upgrades of equipment

- for all types of systems
- replacement of rotating anode generators and sealed tubes


upgrade on a Huber goniometer, Durham


replacement of a RU-200 rotating anode, Boulder

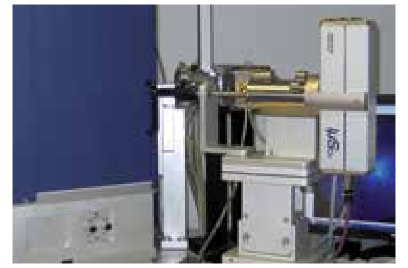

IμS combined with mar dtb, Marburg

Customized solutions

- SAXS/GISAXS for liquids in the lab
- in-situ measurements
- customer-specific unique setups


IμS+Pilatus detector for (GI)SAXS, Bratislava


replacement of an old 18 kW Siemens RAG, Halle


IμS combined with STOE diffractometer, Mainz

More than 150 systems worldwide with highly satisfied customers

The IμS is used in chemical and pharmaceutical companies as well as nanotechnology and semiconductor companies and other businesses involved in materials analysis. In particular, academic and governmental institutions belong to our clientele. The IμS is currently implemented as a key component in more than 150 diffractometry instruments (up to 6/2011) and has been integrated into new equipment of companies such as Bruker AXS, Marresearch or STOE. Incoatec has also installed the IμS as an upgrade for existing diffractometers. For these, our production group takes care of the adaptation, our service team installs on-site and the application specialist carries out the first measurements - all in strict accordance with current safety regulations.
We guarantee with our good reputation the highest level of technology and customer support.

Selection of firsthand customer statements

„For one year now our IμS has been in use regularly for screening purposes, without us worrying about the X-ray source", „The IμS completely meets our expectations.", „I suppose that funding restraints are the only reason not to go with the two-IμS setup.", „The only negative aspect is that we can now collect data on such poor samples that we have to spend much more time on refining disordered and otherwise troubled structures.", „Apart from the superior data quality, it was the prospect of air cooling and low-maintenance which were our main reasons for purchasing ...", „ ... absolutely meets up to our expectations ...", „ ... is excellent ...", „ ... very satisfied ...", „ ... working free from defects and without significant loss in intensity ..."