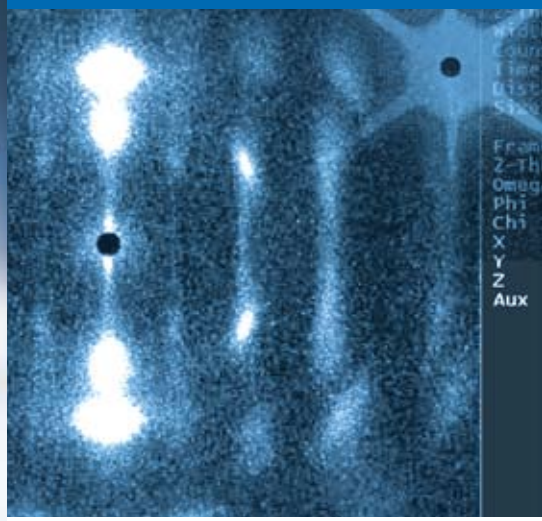
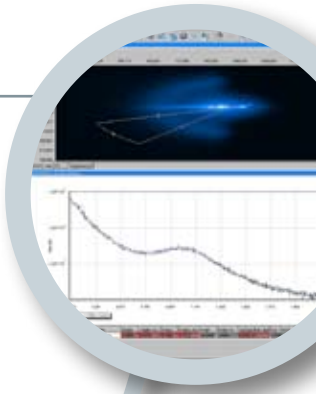


NANOSTAR

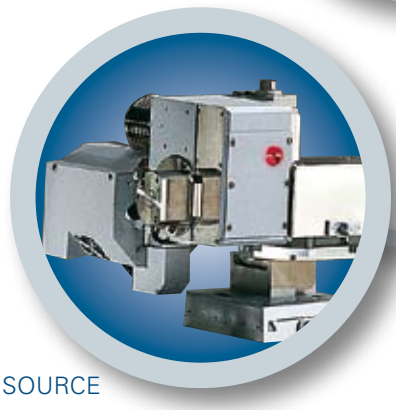
- Small Angle X-ray Scattering Solutions

Innovation with Integrity

SAXS/WAXS/GISAXS



METALJET X-ray Source



TURBO X-RAY SOURCE

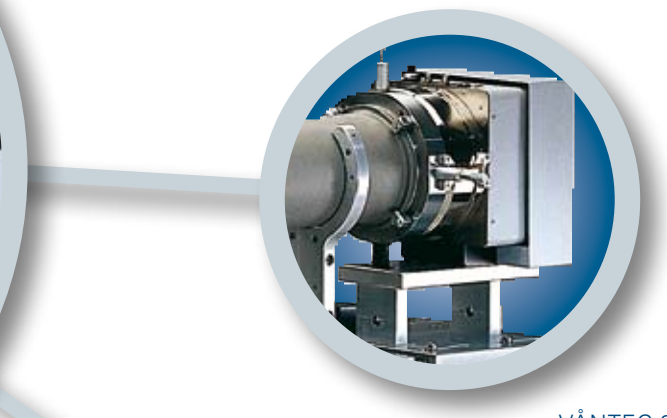
Microfocus X-ray Source

Sealed Tube
X-ray Source

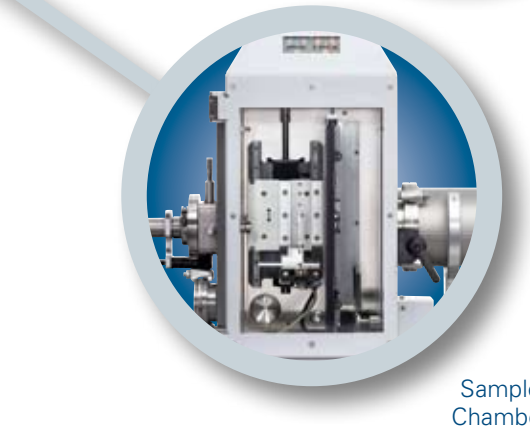
Pinhole
Collimator

DIFFRAC^{plus} LEPTOS

DIFFRAC^{plus} NANOFIT



VÅNTEC-2000
Detector



Sample
Chamber

NANOSTAR – Enter the Universe of Nanostructure Analysis

Today, the most significant advances in the field of metal, metal-organic, and organic material development are gained almost exclusively by defining their properties through the implementation of nanostructures and nanostructured surfaces.

Small Angle X-ray Scattering (SAXS) has proven to be a very reliable, nondestructive method for the analysis of nanostructures. As a matter of fact, SAXS has become a key characterization technique for laboratories and R & D departments concerned with morphological determination of nanostructures.

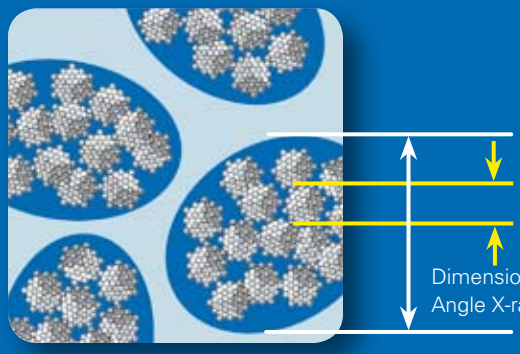
These nanostructures are often realized as thin films. In order to effectively probe thin films and nanostructured surfaces, samples are ideally measured with the X-ray beam at grazing incidence. Thanks to recent developments in X-ray source and detector technology, **Grazing Incidence Small Angle X-ray Scattering** (GISAXS) has become an attractive method to study these nanostructured thin film samples now with lab-based equipment.

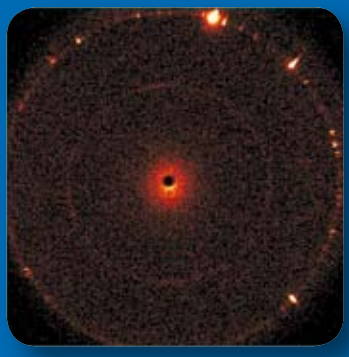
The **NANOSTAR** from Bruker AXS, the world's leading supplier of advanced X-ray diffraction and scattering solutions, adds a new dimension to the advantages of SAXS and GISAXS equipment by having the capability to be tailored to the individual needs of varying customers' applications.

NANOSTAR – your "telescope" to the nano-universe

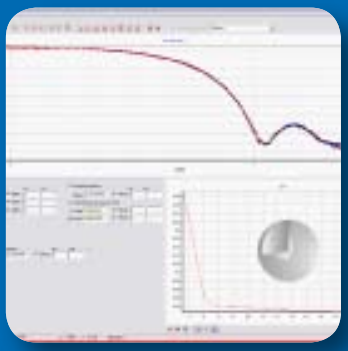
NANOSTAR –
Find Everything in Anything with SAXS

SAXS pattern from a polymer sample





WAXS pattern from a wood sample



DIFFRAC^{plus} NANOFIT

Get information on

- **Size and size distribution**
- **Shape**
- **Orientation**
- **Particle distances**
- **Inner surface**

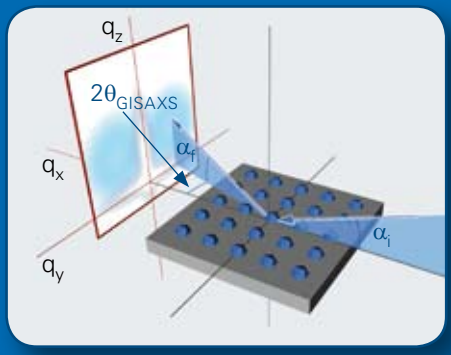
Small Angle X-ray Scattering is a phenomenon caused by particles embedded in a matrix of different electron density. If the particle size ranges from 1 nm to 100 nm, the scattering angle lies within the range of 0° to 5°, depending on the X-ray wavelength used. The smaller the particles are, the wider are the scattering angles. In contrast to SAXS, Wide Angle X-ray Scattering (WAXS) examines structures on the Angstrom level, which are typically interplanar distances of crystalline structures.

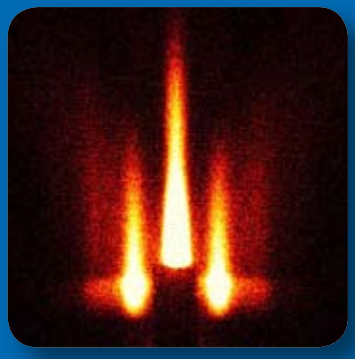
Any arrangement of particles in any medium shows a difference in electron density, which results in a specific pattern when executing a SAXS experiment. Along with the size of the particles, SAXS can also determine their shape, their distance apart and size distribution from the 2-D pattern. Particles can be dissolved macromolecules, precipitations in metals, mineral particles in biological tissues, and surfactant micelles. Using the entire set of information, ultimately the inner surface of the sample can be reconstructed on a nanometer scale.

With DIFFRAC^{plus} NANOFIT, nanoparticles can be modelled by means of geometrical shapes (spherical, cylindrical, etc.) or by dedicated polymer models (chains, Gaussian star, etc.). The corresponding model parameters can be determined in a straightforward way through an interactive evaluation in which the simulated data are compared to the measured data. In addition, information on polydispersity and concentration effects can be extracted as well.

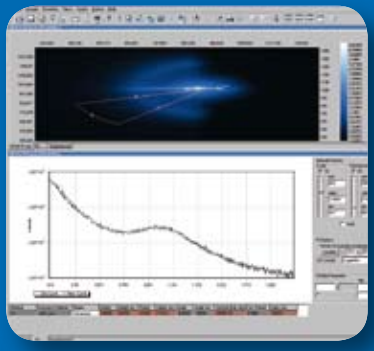
NANOSTAR –
Find Everything in Anything with GISAXS

GISAXS pattern of an unaltered multilayer mirror





GISAXS pattern of a nanostructured surface



DIFFRAC^{plus} LEPTOS

Get information on

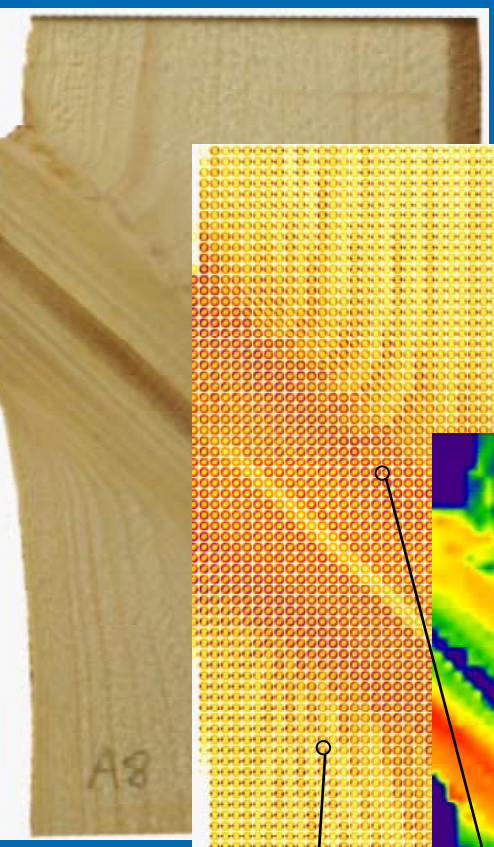
- Dimensions
- 3-D arrangement
- Internal morphologies
- Sub-surface structure
- Roughness

To probe the surface and sub-surface structural details, samples are measured in grazing incidence geometry. The incident angles are close to the so-called critical angle of total reflection and typically lie between 0.1 and 0.7 degrees. By changing the incident angle, different regions of interest on or just below the surface are probed. In a Grazing Incidence Small Angle X-ray Scattering (GISAXS) experiment, the diffusely scattered intensity is collected in the non-coplanar direction by means of a 2-D detector.

Nano-structured surfaces can be measured and quantitatively described in terms of shape, dimensions and arrangement. Even from rough surfaces integral parameters like roughness can be determined. Buried surfaces can be characterized with respect to dimension and 3-D arrangements of structural units.

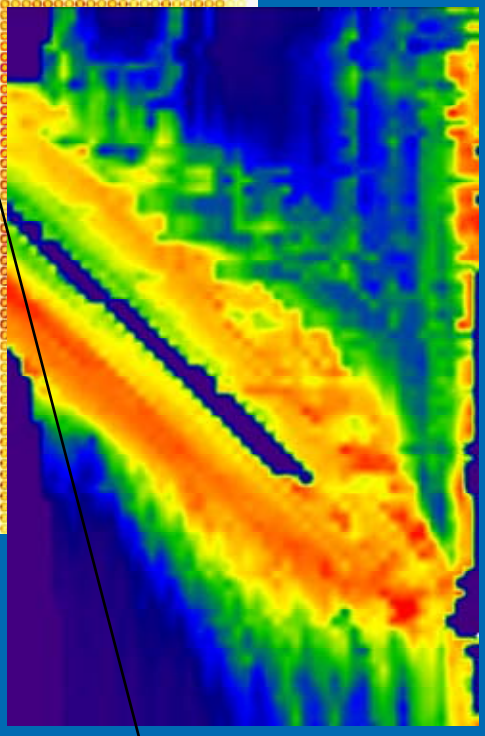
The correct evaluation of data measured at grazing incidence requires dynamical scattering effects being taken into account. DIFFRAC^{plus} LEPTOS provides the sound physical basis for the comprehensive evaluation of 2-D GISAXS data. Several geometrical shape models (cones, cylinders, spheres, prisms, etc.) can be combined with different correlation and distribution models in order to extract information in terms of unit dimensions, 3-D arrangements and correlation lengths.

NANOSTAR –
Fast Sample Mapping

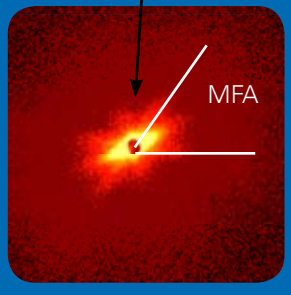


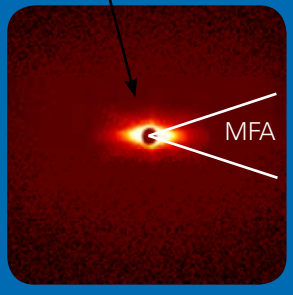
Wood slice

Nanograph



Micro-fibril angle distribution map





The NANOSTAR's automatic XY sample stage permits taking 2-D Nanographs. By point-and-click operation, the spot-of-interest on the sample is selected. Instead of blindly illuminating the sample with radiation, this unique feature of the NANOSTAR can save an enormous amount of effort and time. X-ray Nanography is a powerful tool for displaying and investigating the microscopic structure of specimens on the micrometer scale. In this way, Nanography unifies the nanoworld with the microworld.

The power of this technique is demonstrated by the example on the left. It shows in two dimensions the structural properties of wood, which can be linked to its mechanical properties.

Wood represents a complex hierarchical nanocomposite with helical structure. At the higher hierarchical levels, the wood morphology is dominated by annular rings and branches growing from the stem. Position-resolved SAXS/WAXS on wood slices (8 cm x 4.5 cm; resolution of 0.5 mm) was used to characterize structural properties of the wood at the cross section of a branch and the stem. The position-resolved WAXS data show a varying texture of cellulose nano-fibrils, documenting gradients of helical micro-fibril angle (MFA) across the sample. Since the high MFA correspond to higher flexibility and toughness, the position-resolved measurements reveal also the mechanical function of various wood features. The 2-D MFA distribution nicely illustrates that the stem centers and branch are optimized for higher strains.

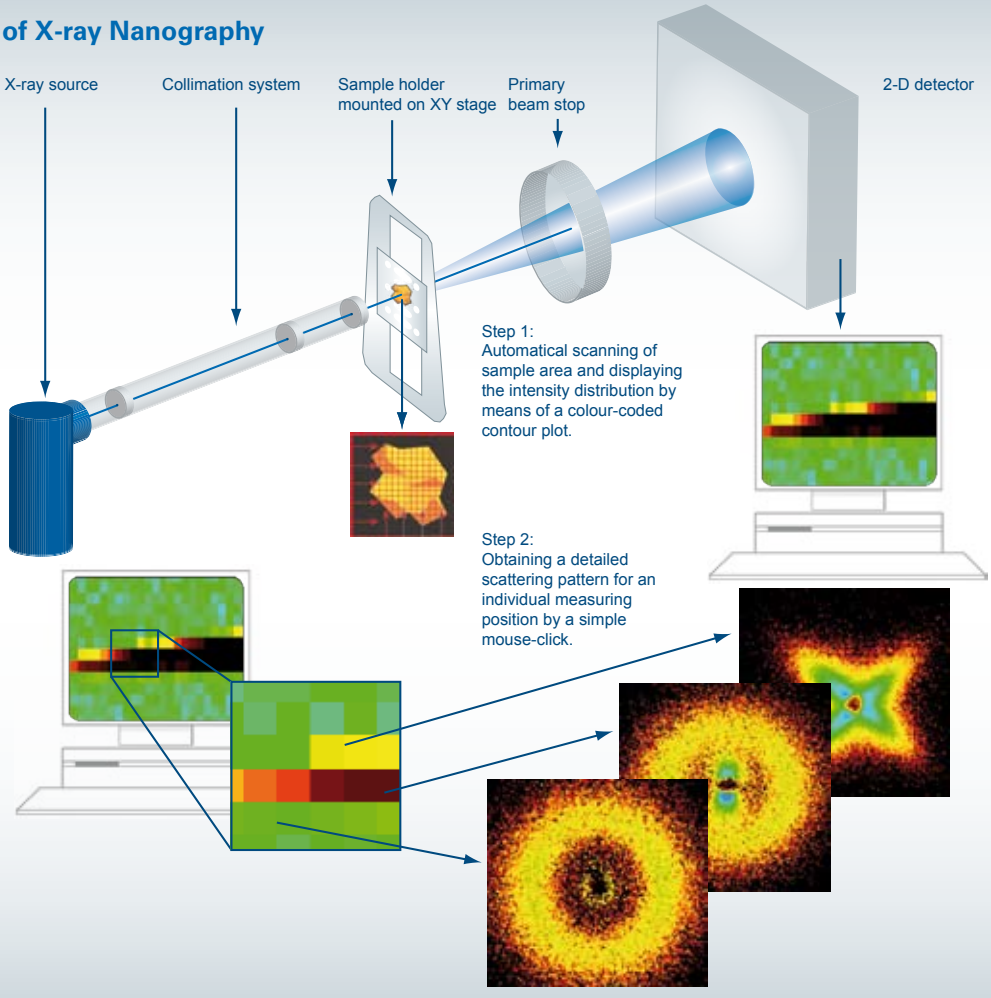
Time-saving, fast sample mapping

- Nanography – automated scanning of samples
- Push-button selection of measurement points
- Automated SAXS measurements

A Nanography investigation requires a specimen to be mounted on a motor-driven XY stage integrated into the sample chamber of the NANOSTAR. This allows the sample to be scanned through the X-ray beam automatically. Nanography shows inhomogeneities such as different chemical compositions or varying density. Nanography permits fast and selective detection of relevant measuring points with inhomogeneous samples and allows even small samples to be positioned precisely. Each individual point of the complete Nanography image itself represents the integral SAXS/WAXS intensity collected by the 2-D detector. The intensity distribution is displayed by means of a colour-coded contour plot. Additional measurement points can then be selected within a Nanograph simply by clicking the mouse on the monitor.

Such Nanographs can also be automatically produced as a series, for example overnight. Up to 18 samples, each with its own respective measuring routine, can be automatically scanned and the data stored by means of corresponding programming via the software.

Principle of X-ray Nanography



METALJET X-ray Source

Unique microfocus X-ray source based on metal-jet technology featuring an unmatched source brightness

TURBO X-RAY SOURCE (TXS)

This high-performance rotating anode X-ray source supplies an extremely intense X-ray beam

Microfocus X-ray Source (IμS)

This unique X-ray source supplies a very stable and intense X-ray beam without the need for water cooling. Thanks to its robust design, the source comes with a 3-year warranty.

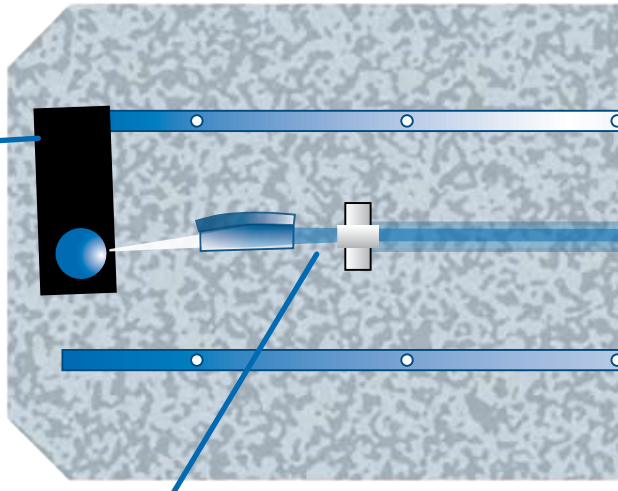
Sealed Tube X-ray Source

X-ray source that features superb stability, long lifetime, and maintenance-free operation

Sample Chamber

Thanks to the generous size of the sample chamber, the NANOSTAR provides enough space to install additional components for individualized handling of samples. A computer-controlled holder for reference samples is built into this chamber.

To operate the system in simultaneous SAXS/WAXS mode, an Image Plate can be placed into the chamber just in front of the rear panel.



Collimation System

The collimation system is available in two setups. Each includes MONTEL optics for conditioning a parallel, monochromatic X-ray beam of high intensity.

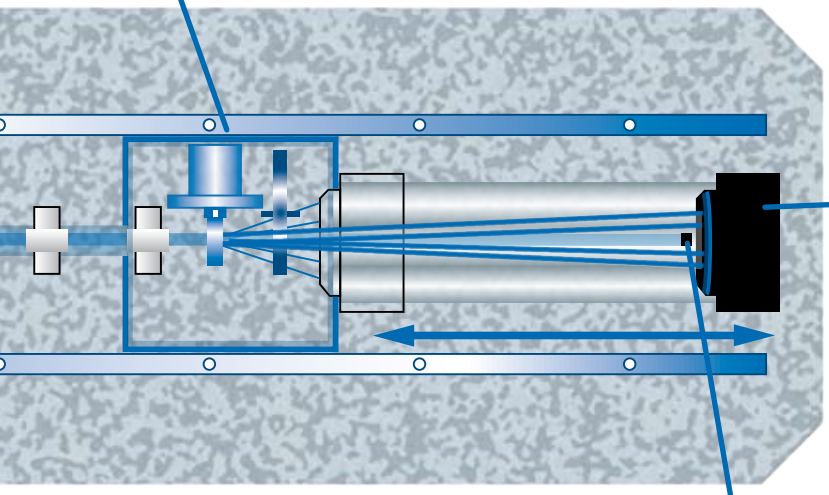
The compact 2-pinhole collimation system forms a fine X-ray beam of a precisely defined size and low background scattering.

A 3-pinhole collimation system can be custom-tailored to individual measuring needs. By selecting larger pinholes, higher incident X-ray intensity can be achieved at minimal divergence. Consequently, shorter measurement times and high resolution can be achieved, even for weakly scattering samples, such as solutions.

NANOSTAR –
Best Components for Best Results

Sample Stage

One of the NANOSTAR's special features is its unique convenience in mounting samples and the possibility of inserting several samples simultaneously, e.g. for testing series. Moreover, samples can be analyzed at different ambient conditions or in GISAXS geometry.



VÅNTEC-2000 Detector

A maintenance-free detector with maximum performance in angular resolution, low background and dynamic range

Primary Beam Stop

The highly absorbent beam stop is mounted with two X-ray transparent wires. The size of the beam stop is optimized for the selected optics.

A semitransparent beam stop is also available for absolute intensity scaling with highest precision.

NANOSTAR –
Modular Design for Top-of-class Results

NANOSTAR U

NANOSTAR C

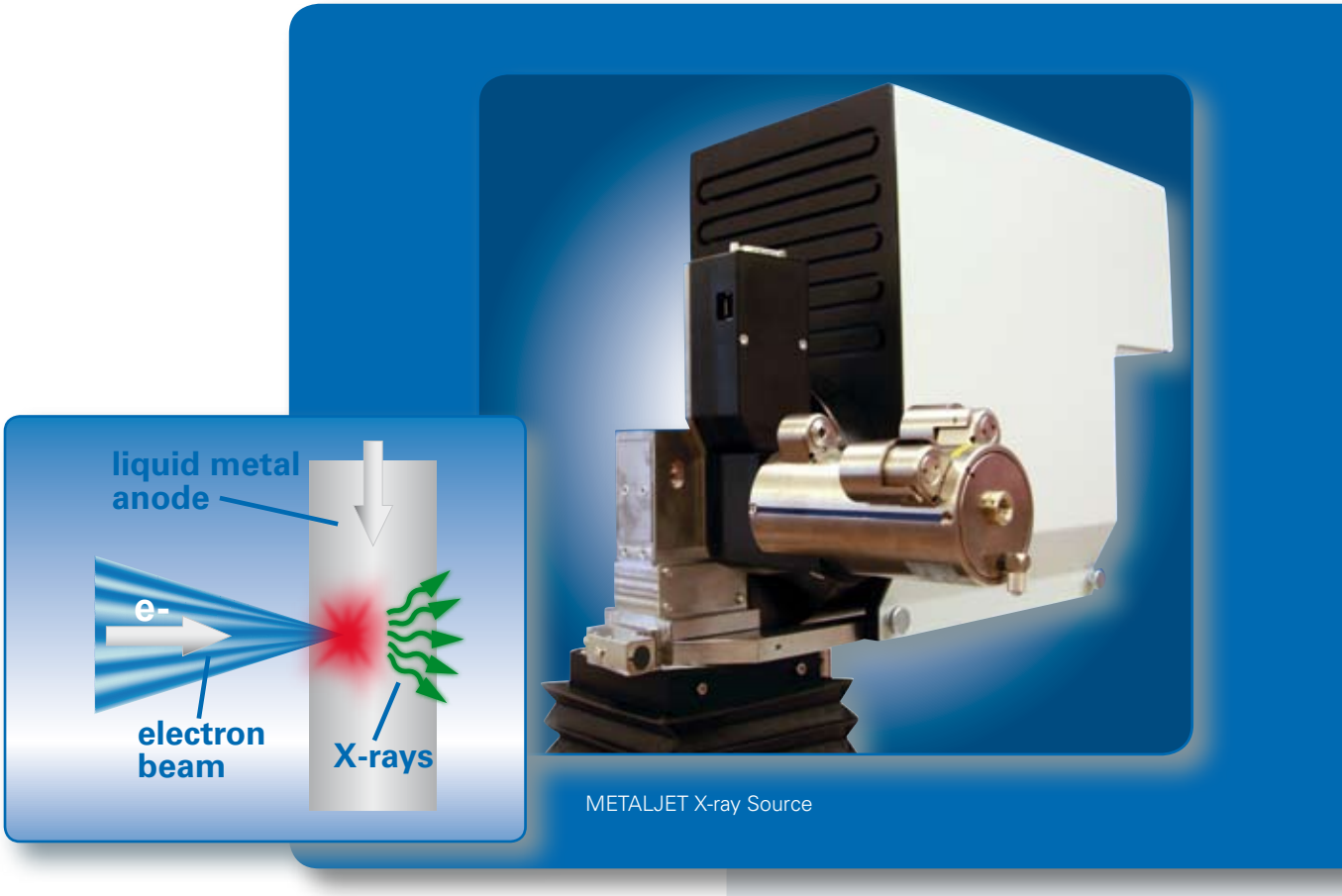
NANOSTAR U

- **Modular setup for greatest flexibility**
- **X-ray sources: sealed X-ray tube, IμS, TXS, METALJET**
- **MONTEL optics with exchangeable 3-pinhole collimation system for high flux/high resolution**
- **Sample chamber accommodating a variety of sample holders**
- **Variable sample-to-detector distance covering a wide q-range**

The **NANOSTAR U** with its incomparable modularity is an ideal solution for analyzing molecular structures ranging from 1 nm to 125 nm and nanostructured surfaces. The 3-pinhole collimation system provides a precisely parallel X-ray beam with high intensity and virtually no background so that fast measuring times and extremely high resolution can be achieved. Consequently, very weakly scattering samples can be analyzed as well as very large structures. The modular design permits setting the detector-to-sample distance from 11.5 mm to up to 1070 mm. Hence, the entire range from SAXS to WAXS can be covered – in combination with the Image Plate (IP) option simultaneously.

The **NANOSTAR C** is designed to have a very small footprint of only 950 mm x 2270 mm. Its compact 2-pinhole collimation system provides an intense beam of only 300 µm at the sample position, which is perfectly suited for analysing solid samples.

NANOSTAR –
Leadership in Technical Innovation



METALJET X-ray Source

The NANOSTAR has always set the benchmark for technological innovations, and continues to do so. Thanks to its open platform design, the latest technologies can be integrated to open doors towards new applications.

Recently, a breakthrough in X-ray source technology was realized with the introduction of liquid metal jet sources. This new type of X-ray source outperforms any of the currently available laboratory X-ray sources. With its unparalleled brightness it is up to 10 times brighter than a conventional rotating anode. Despite this unparalleled performance, the cost of ownership is very competitive compared to rotating anode technology.

The METALJET X-ray source in the NANOSTAR uses liquid gallium as target material, which has a wavelength close to copper radiation. Dedicated MONTEL optics turn these X-rays into a highly brilliant, semi-parallel X-ray beam that is required for very high flux applications such as BioSAXS or time-resolved measurements.

- **Unmatched X-ray source brilliance**
- **Smallest spot size available**
- **Power loading: >500 kW/mm^2**
- **Gallium Kα emission at 9.25 keV**
- **Fully integrated in the NANOSTAR platform**

NANOSTAR –
Maximum Flexibility and Throughput

Sample chamber

Setup for measurement in gas atmosphere

GISAXS sample stage

Heating/cooling stage

Tensile stage

- **Motorized XY stage with up to 80 mm × 130 mm travel**
- **Up to 18 samples can be simultaneously mounted and automatically measured with the standard sample changer**
- **Simultaneous SAXS/WAXS measurements with image plate**
- **Non-ambient measurements from -30°C up to +300°C**
- **Precise GISAXS sample stage with up to 5 degrees of freedom**

The NANOSTAR enables flexible sample handling through a variety of dedicated sample stages and holders for all types of samples, including liquids.

Multi-sample experiments are just as much a part of the program as the possibility of analyzing the same materials under varying conditions (e.g. at various temperatures or atmospheres) quickly and easily.

Using the precise tilt stage, the sample can be aligned exactly for GISAXS measurements.

The large sample chamber is equipped with different types of flanges to accomodate third party sample stages such as Anton Paar's tensile stage or Linkam's shear cell, for particular experiments.

NANOSTAR –
a Sharp Eye on Your Sample

VÅNTEC-2000

SAXS pattern of silver behenate

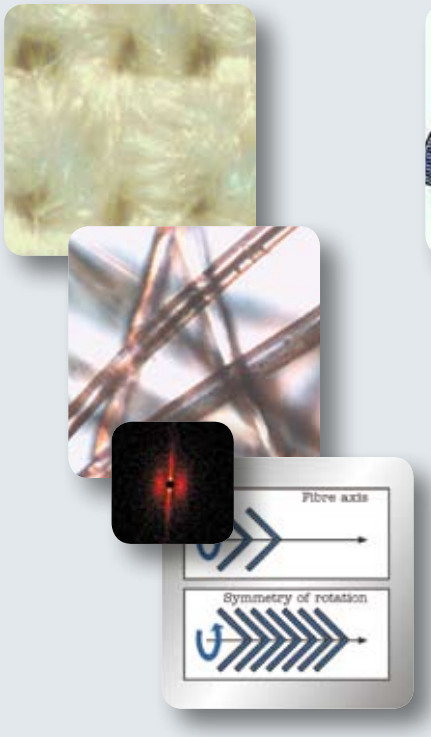
The 2-D detector is the most essential component of a SAXS instrument.

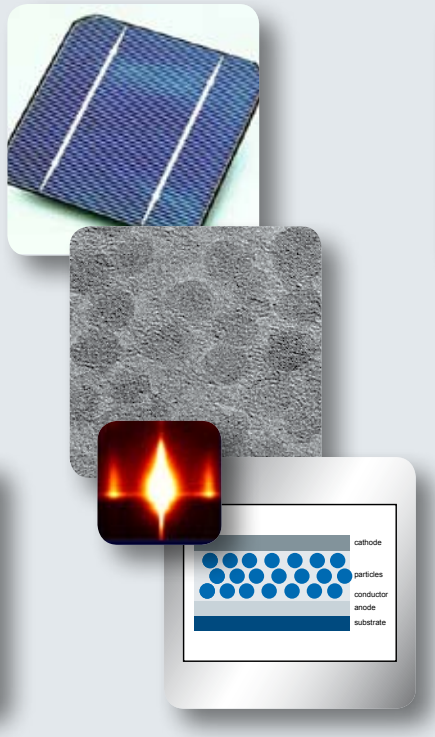
The detector needs a large active area while providing good spatial resolution and very low noise. For a laboratory instrument, a real photon counter with negligible read-out time is the preferable choice. This collection of requirements for an affordable price can only be matched by a gas detector: the VÅNTEC-2000 detector with MIKROGAP™ technology. Its large 14 x 14 cm^2 active area enables a huge angular coverage. Simultaneously, the VÅNTEC-2000 offers excellent spatial resolution with increased dynamical range. Furthermore, the overall data quality is superb due to the intrinsic feature of the MIKROGAP™ technology of showing a uniform sensitivity across the entire active area.

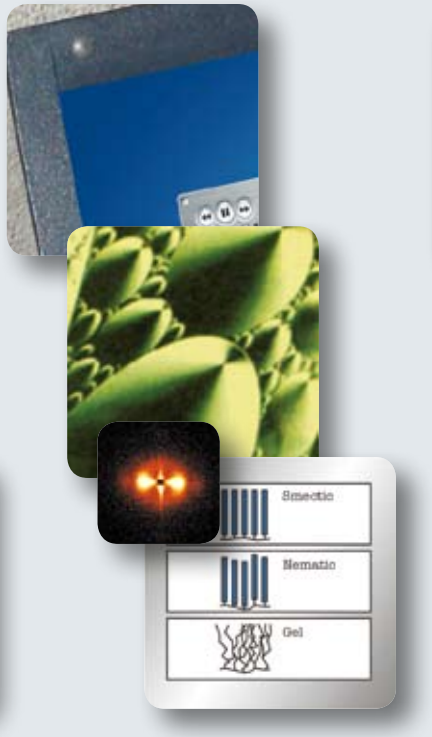
To gain the full benefit from these superb intrinsic detector characteristics, proper manufacturing design is essential. Thanks to extensive experience and in-house detector development, Bruker AXS' VÅNTEC-2000 is guaranteed to be exemplary and without any defective detector area.

NANOSTAR –
Find Everything in Anything: Solids, Proteins, Powders, Liquids…

Macrostructure
Microstructure
Nanostructure







Fibers

The mechanical, optical, thermal or electrical properties of polymeric fibers, composites or natural fibers can be affected by the manufacturing process. By means of SAXS, fibers can be examined during various production routines. SAXS scattering patterns provide information on the orientation of fibers and films. These provide exact data on the structure of these fibers, such as the degree of orientation in individual crystals along a fiber axis.

Solar Cell

The application of inorganic nanoparticles in solar cells leads to a significant rise in efficiency. The key factor of this application is the 3-D arrangement of the nanoparticles. Only this arrangement makes them into an efficiently absorbing compound. Solar cell nanoparticle arrangements can be studied in detail using GISAXS.

Liquid Crystals

Liquid crystals show properties of both a solid material and a fluid. They usually consist of amphiphile, rod-shaped or disc-shaped molecules. These crystals often exhibit anisotropic properties, which are used in LCD displays. When an electrical field is applied, the crystals become oriented. This process is reversed when the electric field is switched off. Through SAXS the arrangements and structural properties of such systems can be studied.

Colloidal Solutions

Surfactants are versatile molecules; they can be used as emulsifiers as well as to modify surfaces or create structures. The most common structures created in this way are micelles, membranes, and vesicles. Vesicles and colloids are utilised to transport active ingredients in cosmetics, medicines, and pharmaceuticals. They can apply, for example, encapsulated light-sensitive vitamins and water to the surface of the skin. A simple example is lipstick.

Today the relevant innovations in high-tech industries and significant knowledge in physical, chemical, and biochemical research come about in spheres that extend down to the atomic range.

Only a precise understanding of the inner arrangement of molecular structures in plastics, metals, active pharmaceuticals, biological and chemical structures will give the researcher an idea about which properties are responsible for specific characteristics of a given material. Once information about the morphology of solids or disperse media is determined, it becomes possible to influence nanostructures selectively, which in turn will affect material behavior at the macro level.

The panel on the left illustrates some examples and the benefits of the structural analysis on the nanometer scale by SAXS/GISAXS. The parameters obtained are directly related to sample properties on the micro- or macrostructure scale.

Prediction of a material's properties is one of the main objectives for performing SAXS/GISAXS investigations.

SAXS/GISAXS – small angles for big results

Fibers

Polymeric fibers, composites, and natural fibers are analyzed to obtain orientation and degree of ordering. Even the internal structure of individual fibers can be studied.

Colloids

Gels, sols, aggregation processes, charge or sterically stabilized sols, and templating nanomaterials: these are samples where SAXS can help derive information about size, size distribution, shape of particles, interparticle interactions, and gelation or aggregation state.

Biological materials

In membranes or bones, e.g. cross-section, structure and interlamellar ordering is analyzed. In proteins, DNA/RNA, and other biomolecules, SAXS detects shape, structure, and aggregation state.

Metals

SAXS provides information on particle size and shape, composition, volume fraction and even interparticle correlations of precipitations in alloys, nano-crystals and nano-powders.

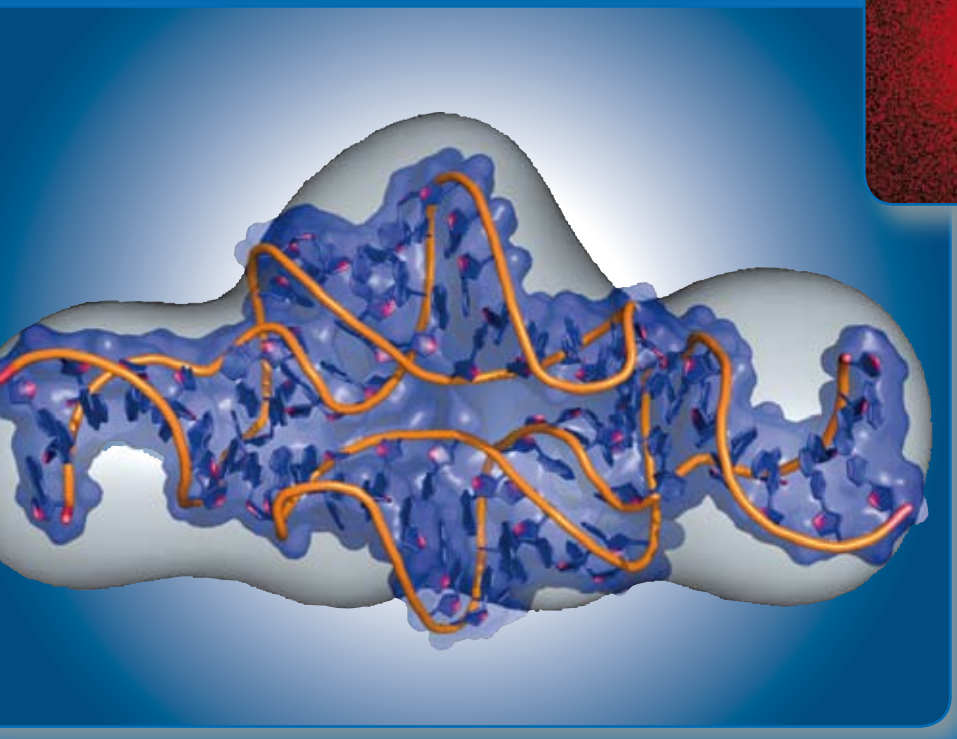
Complex fluids, liquid crystals

SAXS provides information on size and shape of particles, interparticle interactions, degree of crystallinity, and phase transitions in liquid crystals.

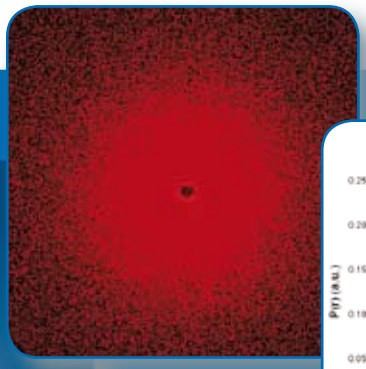
Polymers

For bulk- or semi-crystalline polymers and block copolymers, the mesophases are characterized by SAXS. For polymer solutions and block copolymer micelles in solution, the osmotic compressibility, molecular mass, and radius of gyration or correlation can be obtained. Additional information on intermicellar interactions and on the structure and shape of the micelles can also be extracted.

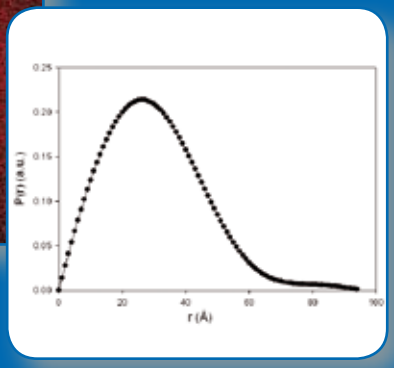
NANOSTAR –
Competence in BioSAXS



3-D envelope model (blue mesh) determined from SAXS data collected with the NANOSTAR



SAXS pattern of an RNA protein complex



Corresponding Pair Density Distribution Function.

Get information on

- **Molecular volume and mass**
- **Radius of gyration**
- **3-D envelope describing macromolecular size and shape**
- **Conformational changes**
- **Aggregation state**

Biomolecular structural research attracts lots of interest as it is indispensable for a better understanding of biological processes. Together with protein crystallography and Nuclear Magnetic Resonance (NMR), BioSAXS is one of the key characterization techniques for studying biological macromolecules, as individual proteins or as large complexes in solution.

BioSAXS enables the accurate determination of the envelope shape of biomolecules in native conditions.

Furthermore, information on macromolecular shape, molecular weight or aggregation state can be obtained even from poorly crystallized samples.

In grazing-incidence mode, GISAXS can be used for studying biological molecule layers on surfaces.

The NANOSTAR with its high-flux X-ray sources, in particular the METALJET source, provides superior data quality even for highly diluted biological samples and discloses even small structural changes.

NANOSTAR Applications

	Typical Samples	Information obtained by SAXS	Practical Use
Fibers	Polymeric fibers Composites Natural or artificial fibers	3-D structure Orientation Orientation distribution Internal structure of fibers	Improve mechanical, optical, thermal, and electrical properties Derive the structural models for the internal organization of fiber samples
Metals	Metals and alloys Precipitates in alloys Nano-crystals Nano-powders	Size (distribution) and shape of precipitates Composition and volume fraction Inter-particle correlations	Design alloys with dedicated mechanically improved properties Quality control during processing
Colloids	Gels, sols Aggregation processes Templating nanomaterials	Size (distribution) and shape Inter-particle interactions Geletation/aggregation state	Examine the sol to gel phase transition Study the behavior of micellar aggregation Observe the formation of colloids
Liquid Crystals	Piezoelectric materials Colloidal suspensions Displays for electronic devices	Size (distribution) and shape Inter-particle interactions Degree of crystallinity Phase transitions	Optimizing electro-optical devices and liquid crystal membranes Controlling the quality of stabilized matrices with fixed optically active molecules
Nanostructured Surfaces	Quantum dots Self-assembled Nano-particles on surfaces	Size, distribution, shape Degree of self-assembly	Medical and biological research Wires for devices Catalysts
Polymers	Bulk polymers Semi-crystalline polymers Block copolymers Polymer solutions Synthetic polymers (e.g. plastic)	Lateral and bulk order Periodicities Molecular mass Structure and shape	Characterize the morphological effects of drawing, rolling, and annealing on mechanical properties of polymers Examine the ability of polymers to act as hosts for low-molar mass organic guest molecules (Nanocontainer)
Biological Materials	Proteins, DNA/RNA Biological membranes Biological solid structures and tissues	Size and shape Structural arrangement State of aggregation Thickness and perfection of wrapping	Determine collagen orientation and the structural organization of the collagen-mineral composite Resolve the structure of huge protein/RNA/DNA complexes in their native environment

NANOSTAR Glossary – Explanations and Additional Aspects

AFM	Atomic Force Microscopy is a surface imaging technique that uses a cantilever with sharp tip to scan the specimen surface. Forces between the tip and the sample give rise to deflections of the cantilever.
Amphiphile Molecules	Molecules that consist of a water-soluble and a water-insoluble constituent (hydrophilic and hydrophobic).
Angstrom/Nanometer	1 Angstrom = 10^{-10} m, 1 nanometer = 10^{-9} m
Anisotropy	Describes the dependence of material properties or parameters on the direction in space.
Biological Materials	Used here as a collective term for biological membranes, related membranes, tissues, proteins, DNA/RNA, macromolecules and complexes thereof.
BioSAXS	Small Angle X-ray Scattering of biological macromolecules.
Collagen	A fibrous scleroprotein of connective tissue and bone that is rich in glycine and proline.
Colloids	State of matter characterized by a uniform distribution of particles of the order of 1 nm to 100 nm size dissolved in a liquid.
Complex Fluids, Emulsions	General term for mixtures of liquids which commonly don't dissolve in each other. They show solid-like behaviour due to their molecular interactions. They are widely used for cosmetics or pharmaceuticals.
Dispersive Materials	As a chemical definition it is a mixture of at least two materials which can either not dissolve in each other or do not react with each other chemically.
Fibers	Elongated structures widely found in fauna and flora, such as single cells, cell strands, bundles of cell strands, or as a building block of cells. Commonly native and artificially manufactured fibers (e.g. polymer fibers) are distinguished.
Fibrils	Biological sub-unit of fibers.
GISAXS	Grazing Incidence Small Angle X-ray Scattering, a novel technique for investigating structures on or close to the surface.
IμS	Air cooled high-brilliance Microfocus X-ray source with MONTEL optics.
Liquid Crystals	Materials combining the typical properties of liquids (flow characteristics) with those of solids (anisotropy of certain physical properties).
Membranes	Thin layers of tissue that limit or separate regions or structure in biological materials. In technology, for example, membranes are utilized as molecular sieves.
METALJET	This innovative, extremely bright X-ray source uses liquid gallium metal as anode material. A much higher power load can be realized on such a liquid target compared to conventional X-ray sources using solid targets, since the latter are limited by the melting of their target.

NANOSTAR Glossary

Metals	Metals or, more precisely metal alloys, are complex materials synthesized from a wide variety of elements. Depending on the material treatments during synthesis, the precipitants in the alloy may arrange differently or may segregate. Typically metal alloys show a very complex phase diagram depending on e.g. temperature and composition.
Micelles	When dissolved in water, amphiphile molecules can form small aggregates known as micelles. The hydrophobic, water-repellent component of a molecule is directed inwardly and the hydrophilic constituent outwardly.
MONTEL optics	The X-ray optical module consists of a pair of Göbel Mirrors arranged side by side with a 90° angle to each other. By capturing a large solid angle, the parabolically shaped mirrors turn the radiation emitted by the spot focus source into a high-brilliant parallel beam while suppressing Kβ radiation.
Morphology	The analysis of shapes, forms and structures of substances and organisms.
Nanography	A term introduced by Bruker AXS that is directly derived from the term radiography. X-ray Nanography refers to the non-destructive analysis of nanometer-scale structures by scanning a mm-sized sample area with µm-resolution.
Nanopowders, Nanocrystals	Powders or crystals containing particles whose size is on the nanometer scale.
Nanostructures	Nanostructured materials comprise unusually fine architecture with structures ranging from 1 nm to about 100 nm.
Polymers	Synthetically manufactured (synthetic polymers, e.g. plastics) or naturally occurring macromolecules (biopolymers, e. g. polysaccharides) which are composed of many of the same or similar constituents.
Small Angle X-ray Scattering (SAXS)	Allows investigation of nanostructures from 1 nm up to about 100 nm in size. With copper radiation, these sizes correspond to an angular range of about 4.4° for 1 nm to about 0.044° for 100 nm. A prerequisite for obtaining a signal is the presence of differences in the electron density of the sample to be analysed.
TXS	TURBO X-RAY SOURCE, a rotating anode generator for increased flux.
Unaltered Samples	Samples which were not treated chemically, thermally or mechanically prior to examining their micro- or nanostructural morphology.
Vesicles	Round to oval structure that is enclosed by a simple membrane.
Wide Angle X-ray Scattering (WAXS)	Describes scattering at angles above about 2.5° and allows investigating structures at the Angstrom level.
X-ray Diffraction	The coherent and elastic scattering of X-ray radiation by periodic arrays of objects resulting in concerted constructive interference at specific angles. Elastic scattering means no energy change and respectively no wavelength change. If the periodic array consists of crystalline matter in a 3-D arrangement of atoms, monochromatic X-ray radiation diffracts in a number of different directions in 3-D space, creating a diffraction pattern.

Technical Data

X-ray source

	Sealed Tube	IμS	TXS
Maximum power in for Cu (kW)	1.5	0.03	1.2
Flux density at sample (cps/mm^2, pure Kα radiation)	0.3 × 10^7	1.7 × 10^7	2.7 × 10^7

Note: About one order of magnitude higher flux densities can be achieved at the cost of spectral pureness.

X-ray optics

MONTEL optics,

3-pinhole collimation system
Pinhole diameters for high flux (μm): 750, 400, 1000
For high resolution (μm): 500, 150, 500

2-pinhole collimation system
Pinhole diameters (μm): 100, 300

Sample stages

XY stage
Up to 80 mm × 130 mm travel, positional resolution: 10 μm

GISAXS stage
Tilt stage with up to 5 degrees of freedom

Temperature units
Cooling/heating unit: -30 °C to +120 °C
Heating unit: RT to +300 °C

Sample holders

Liquid sample
Vacuum tight quartz capillaries

Powder and bulk samples

Reference sample holder

Wide angle sample holder

Detector

VÅNTEC-2000

Patented MIKROGAP™ technology detector, high spatial resolution with increased dynamic range

- real time data collection and display
- maintenance-free
- max. 2048 × 2048 pixel frame
- 14 × 14 cm^2 active area
- pixel size 68 × 68 μm^2

Primary Beam Stop

Fixed with X-ray transparent wires, alignment accuracy better than 10 μm
Material: fluorescence-free highly absorbent or semi-transparent

Resolution

Distance (mm)	q-min (Å^{-1})	Particle size (Å)
60	0.3	21
270	0.04	150
670	0.01	628
1070	0.005* for NANOSTAR U 0.01 for NANOSTAR C	1250* for NANOSTAR U 628 for NANOSTAR C

With Image Plate detector maximum angle is 80° 2-theta at 11.5 mm distance
*dependent on pinhole combination and size

www.bruker.com

Bruker AXS GmbH
Karlsruhe, Germany
Phone +49 7 21 5 09 97-0
Fax +49 7 21 5 09 97-56 54
info@bruker-axs.de

Bruker AXS Inc.
Madison, WI, USA
Phone +1 800 234-XRAY
Tel. +1 608 276-3000
Fax +1 608 276-3006
info@bruker-axs.com

Measurements by courtesy of:
P. Fratzl, C. Buksnowith, W. Gindl, L. Chitu, G. Maier, J. Kreith and J. Keckes