Photonic Science

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X-RAY GEMSTAR CAMERA

X-Ray Powder Diffraction method is one of the few non-destructive methods that permit the identification and the elemental analyze of materials.

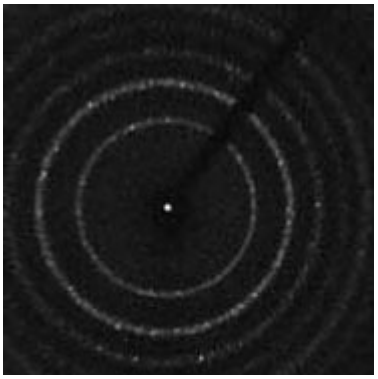
As the X-Ray diffraction pattern of a crystalline substance is unique, it is possible to characterize and thus to identify any polycrystalline substance (phase).

In order to understand the diffraction pattern, either the incident beam is monochromatic or the X-Ray detector is able to resolve the energy from the Kα1, Kα2 doublet to the Kβ1 line. Alternatively, Sollers slits / optics can be used in order to select the corresponding angular range.

A resolution better than 450eV is necessary (FWHM of the measured Cu Kα1, Kα2 doublet).

Diffraction patterns consists of rings, high intensity spots due to crystallized materials, which are mixed to the existing phases are averaged over continuous sample rotations. Intensity integration over those rings allows pattern indexation.

Near photon counting sensitivity maybe required for standard laboratory X-ray sources whereas high brilliance sources such as microfocus / synchrotons will require good dynamic range: typically 15,000:1 and large area 100 x100mm. One to two megapixel detectors with spatial resolution of 60-120 microns is usually sufficient.

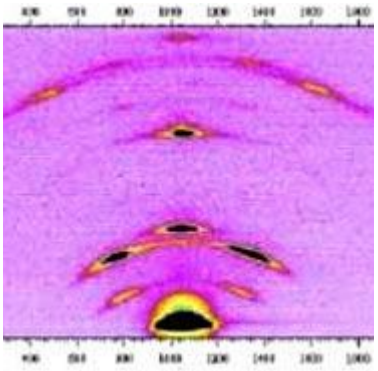


Powder Diffraction

SAXS / WAXS technique is used to reveal order / disorder at large, micro or nano scale in non-crystallized materials: i.e. polymers, proteins in solutions, oil, colloids, and plastic.

A typical experimental set-up requires a highly collimated X-ray source and a detector with photon counting sensitivity as the intrinsic process behind small angle x-ray scattering is very inefficient. Ideally both small angle and wide angle detectors are combined in order to characterize simultaneously short and longer ranges of scattering vectors.
For instance, WAXS will be used to determinate the degree of crystallinity of polymer samples. SAXS is capable of delivering structural information of macromolecules between 5 and 25 nm with averaged particle sizes, shapes, distribution, and surface-to-volume ratio, of repeat distances in partially ordered systems of up to 150 nm. USAXS (ultra-small angle X-ray scattering) can resolve even larger dimensions. SAXS WAXS patterns consist of low intensity patterns acquired over minutes of integration requiring very low background noise and good signal discrimination. Coexistence of bright and very bright signals on the same image could require dynamic range up to 106:1 using multiple exposures.

Large area detectors up to 200x200mm and 16 megapixel resolution are used in synchrotrons whereas smaller input size detectors: typically 60 to 90mm and 1 megapixel resolution are used with laboratory sources.



SAXS / WAXS

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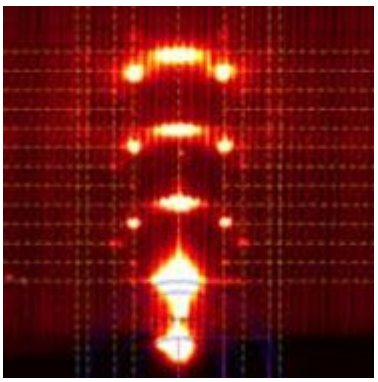
X-ray Reflectometry (XRR) is used for measuring the thickness, density and surface quality of thin film layers deposited on a substrate.

Grazing incidence geometry is used near the total external reflection angle of the sample material. Measurements of X-ray intensity reflected from the sample as a function of angle gives a pattern of interference fringes, which is analyzed to determine the properties of the film layers responsible for creating the fringe pattern.

The detector usually records more than 10 reflection orders, this requires high dynamic range with the ability to detect very low flux for unveiling the very last reflections whilst coping with the strongest first order reflections. Integrating intensities over a 2D detector allows a large angle collection at once: ie typically >4 degrees without any scanning requirements.

Detectors with 56x28mm or up to 80x30mm can be offered.

Linear scanning will allow fast acquisition routines with a few millisecond read out time and 100% duty cycle. This delivers optimum sensitivity and dynamic range whereas area scanning will allow large angular collection at the expense of a longer read out cycle.



Reflectometry, Thin Film Analysis

Wavelength Dispersive X-ray Spectroscopy is used to count the number of X-rays of a specific wavelength diffracted by a crystal.

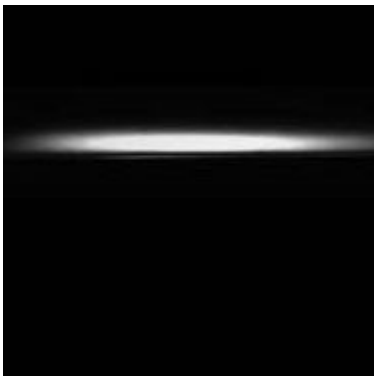
The single crystal, the specimen and the detector are mounted precisely on a goniometer with the distance from the source of X-rays (the specimen) and the crystal equal to the distance from the crystal to the detector.

The technique is often used in conjunction with EDS, where the general chemical make-up of an unknown can be learned from its entire spectrum.

WDS is mainly used in chemical analysis, in an X-ray fluorescence spectrometer or in an electron microprobe.

The detector geometry must allow good angular coverage for mapping all wavelengths in a single acquisition without having to move the detector.

Detectors with 80x30mm active area can be offered with both linear scanning or area scan modes, 100% duty cycle, optimum sensitivity and dynamic range. Temporal resolution down to <100 nanoseconds with 30KHz repetition rate can be offered for pump probed experiments.



Wavelength Dispersive X-ray Spectroscopy

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X-RAY GEMSTAR CAMERA

High Energy Non Destructive Testing from 225keV up to >1 MeV, a new approach to industrial scanning requiring high resolution and high sensitivity.

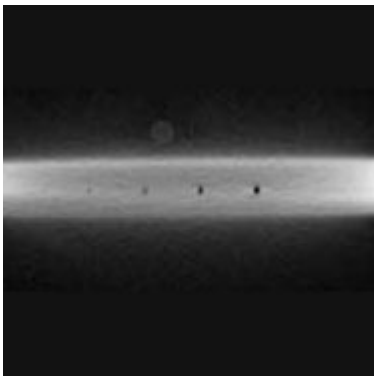
The use of high energy X-rays has applications in the fields of security, nuclear industry, oil and gas exploration as well as material / chemical science industries.

The detectors can provide multiple energy selection when used with a suitable scintillator / geometry. This can produce a “color” profile from multiple X-ray photon energies up to MeVs.

The detector allows to change from one dimensional scanning to two dimensional imaging geometries, depending on the energy used / dose / resolution sought. Active areas up to 450x225mm with 245 microns pixel size are available.

Gamma imaging is a particular case. We can supply special gamma cameras for detecting / imaging nuclear residues when decommissioning specific areas in nuclear plants.

Gamma cameras with state of art line collimators are also offered for high resolution drum inspection with increased sensitivity at 1.3MeV.



High Energy Non Destructive Testing / Gamma Imaging