Photonic Science

Millham, Mountfield, Robertsbridge, E.Sussex, TN32 5LA
Email: info@photonic-science.com
Tel.: +44 (0)1580 881199 Fax: +44 (0)1580 880910
Web site: www.photonic-science.co.uk

X-RAY XEM CAMERA

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

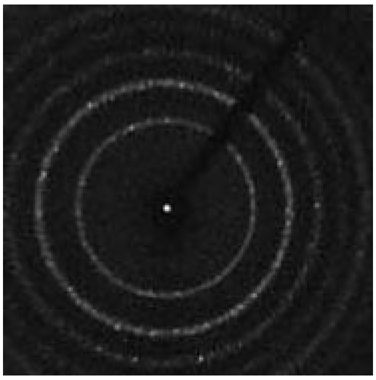
As the X-Ray diffraction pattern of a crystalline substance is unique, it is possible to characterize and thus to identify any polycrystalline substance (phase).

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

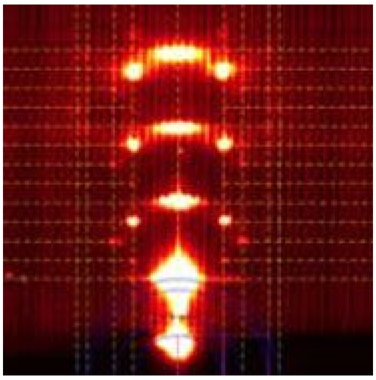
X-Ray Reflectometry (XRR) is used for measuring the thickness, density and surface quality of thin film layers deposited on a substrate.

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

Photonic Science

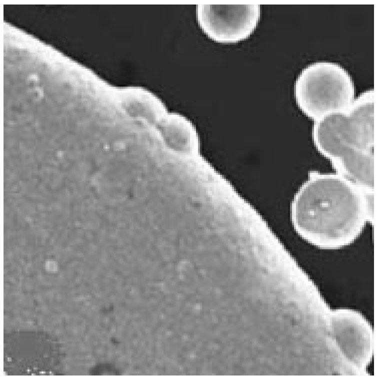
Millham, Mountfield, Robertsbridge, E.Sussex, TN32 5LA Tel.: +44 (0)1580 881199 Fax: +44 (0)1580 880910
Email: info@photonic-science.com Web site: www.photonic-science.co.uk

X-RAY XEM CAMERA

Transmission X-ray Microscopy produces contrast using the difference in absorption of soft X-ray in the water window region.

Wavelength region: 2.3 - 4.4 nm, corresponding to photon energy region of 0.28 - 0.53 keV is where the carbon atom (main element composing the living cell) and the oxygen atom (main element for water) deliver good imaging contrast.

A typical set up consists of polychromatic source used with condenser optic that relays the radiation onto the sample and a Fresnel zone plate is used in order to magnify the image onto the camera. The latter is a very high resolution cooled high sensitivity CCD camera coupled to a state of art scintillator using high NA lens with 1.4 micron effective pixel size.



Transmission X-ray Microscopy

An alternative solution using direct exposure of the CCD to soft X-ray is also available with 13 microns pixel size.

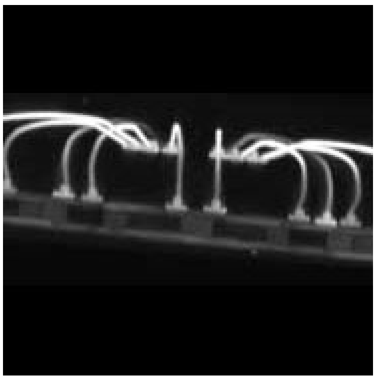
An other technique, known as lens less coherent diffraction imaging is emerging as a potential technique for enhancing resolution down to 1.5 the radiation wavelength. It also enables to eliminate a low transmission FZP.

Combined with XANES (by taking an image above and below the absorption edge of an element), the camera can unveil information about the chemical state of components in the sample.

X-ray Tomography allows a 3D reconstruction from a series of radiographs for different angular positions of the sample down to sub micron resolution.

Typically a full tomographic data set will require in the order of few hundreds to a few 1000s radiographs using a 3D reconstruction Feldkamp algorithm. Optical Cone beam / fan beam reconstruction are used, with the sample rotating in a fixed plan / helicoidally around an axis perpendicular to the beam.

The total acquisition time is in the range of few seconds per frame, it depends very much on the source brilliance / geometry. 100% duty cycle detectors with simultaneous read out / exposure allows to save up to 50% of the scanning time.



X-ray Micro and Nano Tomography

Resolution down to a few hundred nanometers can be achieved by using a small focal spot source and reasonable geometric magnification. The recorded data is often several Gigabytes and can be processed using the massively parallel calculation capacity of GPUs.

Microtomography can be combined with phase contrast imaging, either in a qualitative way (“edge enhancement”) or, more quantitatively, including phase retrieval (“holotomography”). Very high resolution cameras allows the build of scanners with sub micrometer spatial resolution whilst keeping compact dimensions and good sensitivity.

Millham, Mountfield, Robertsbridge, E.Sussex, TN32 5LA Tel.: +44 (0)1580 881199 Fax: +44 (0)1580 880910
Email: info@photonic-science.com Web site: www.photonic-science.co.uk

X-RAY XEM CAMERA

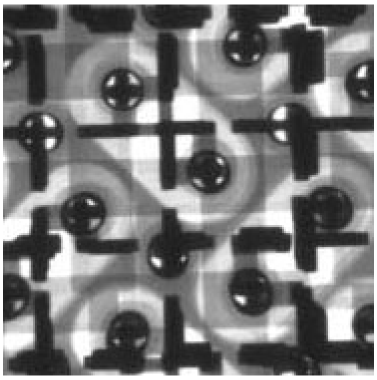
Industrial PCB X-ray Inspection / Digital X-ray Radiography cameras are used to detect porosity, inclusions, cracks and even grain structure within a variety of cast components and in welded joints.

With the increasing production of many new types of components such as BGA and flip-chip devices, it is important to produce good quality real-time X-ray images to isolate dry joints, bridging/shorts, voiding, misplacement / misalignment problems down to few microns or less resolution.

A high resolution camera is used in conjunction with high geometric magnification in order to keep a compact system that includes moving stages. The same kind of set up can be used for inspection of the latest ceramic, plastic and composite structures as well.

The cameras required for this kind of routine exposure time of < 500ms per frame and good enough resolution: typically better than 25 microns minimum feature detection capability in order to keep the geometric magnification requirements.

This keeps the overall instrument dimensions as low as possible. Simultaneous read out and exposure cycles are usually necessary for keeping duty cycle as close as possible to 100%, thus enabling higher board inspection throughput.



Industrial PCB X-ray Inspection / Digital X-ray Radiography.

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

Photonic Science

Millham, Mountfield, Robertsbridge, E.Sussex, TN32 5LA Tel.: +44 (0)1580 881199 Fax: +44 (0)1580 880910
Email: info@photonic-science.com Web site: www.photonic-science.co.uk

X-RAY XEM CAMERA

X-ray Angiography / Fluoroscopy is performed to specifically image and diagnose diseases of the blood vessels of the body, including the brain and heart.

Traditionally, Angiography was used to diagnose pathology of vessels suffering from blockage caused by plaque built up.

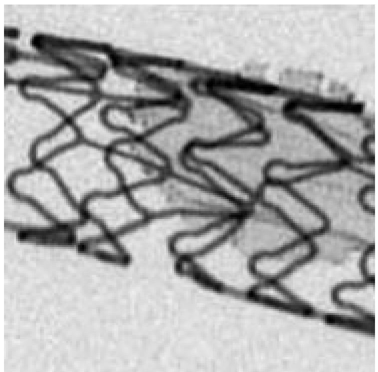
However in recent decades, radiologists, cardiologists and vascular surgeons have used the X-ray Angiography procedure to guide minimally invasive surgery of the blood vessels and arteries of the heart.

The detector must deliver good enough spatial resolution, contrast and be sensitive enough in order to minimize the dose incurred by both patients and surgeons.

Recent trials have shown that it is possible to decrease the instrumental noise equivalent exposure down to less than 0.1 microrad.

This new technology should provide improvements over current flat-panel detectors for applications such as fluoroscopy and angiography.

This requires high frame rates, good spatial resolution, dynamic range and sensitivity while maintaining essentially no lag and very low instrumental noise equivalent exposure.



X-ray Angiography / Fluoroscopy