SIGRAY

PrismaXRM

SUBMICRON 3D X-RAY MICROSCOPE

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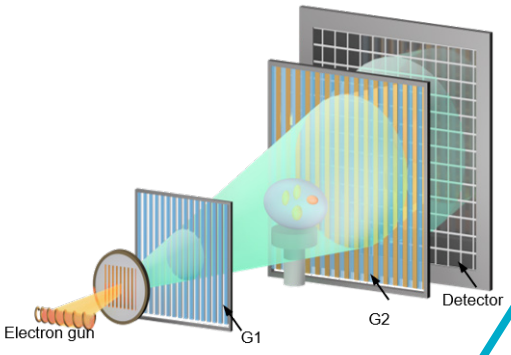
PrismaXRM is a flexible, customizable system. It incorporates the latest developments in x-ray technology, including a diamond backed transmission x-ray source, diffractive x-ray gratings, and novel photon counting detector technology



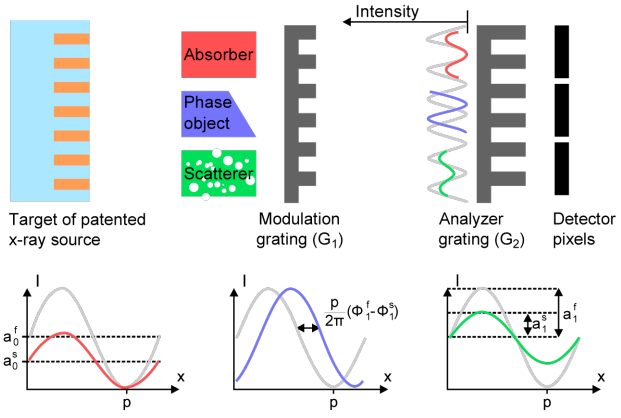
...see things **never seen before** using novel x-ray contrast mechanisms

PrismaXRM Advantages at a Glance

» Industry leader in spatial resolution of 0.5 µm with breakthrough contrast

» Quantitative Phase™: a completely new phase contrast mode that provides **quantitative** access to refractive index and compositional information

» Subresolution Darkfield™ (*): microstructural changes, including cracks and voids, that are otherwise invisible in absorption contrast **can be seen** with Darkfield contrast



How does the system provide tri-contrast?

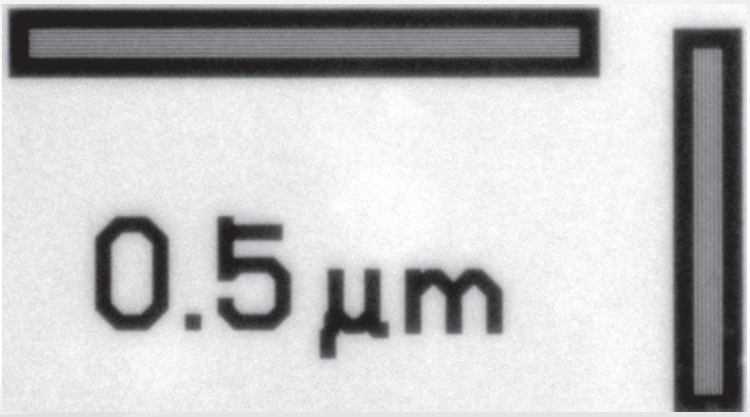
PrismaXRM uses a novel grating-based geometry that deciphers the information encoded in x-rays passing through a sample. X-rays are absorbed, refracted, and scattered when interacting with a sample. In a standard microCT/x-ray microscope, most of this information is lost and only absorption of x-rays can be measured. The PrismaXRM provides full access to the signal information to help unlock new discoveries in scientific research.

(*) Subresolution Darkfield acquires a scattering signal that is stronger for small features. Features, such as 100s nm cracks or hidden pore networks that are beyond the resolution limit of the system, can be detected using this approach.

PrismaXRM breaks through the visibility limits of existing x-ray microscopes with industry leading spatial resolution and new forms of x-ray contrast.

Industry Leading Resolution for 3D XRM/MicroCT

3D x-ray microscopy at ultrahigh 0.5 µm spatial resolution.
Submicron resolution maintained at large working distances.



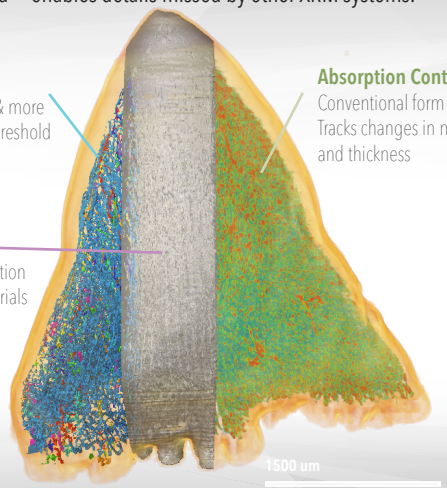
Novel Tri-Contrast Tomography Allows You to See More

Simultaneous acquisition of absorption with Quantitative Phase™ and Subresolution Darkfield™ enables details missed by other XRM systems.

Subresolution Darkfield™:
Finds hidden pore networks, cracks, & more
Features beyond spatial resolution threshold

Quantitative Phase™:
Measure refractive index for composition
Ideal for biological & polymeric materials

Absorption Contrast:
Conventional form of imaging
Tracks changes in mass density and thickness



A Revolutionary MicroXRM Design

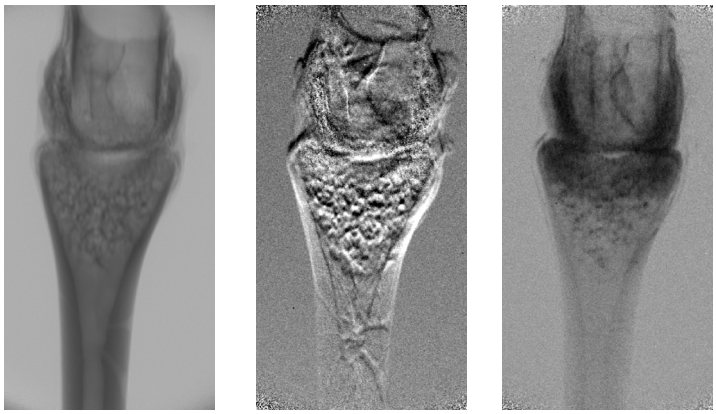
Breakthrough X-ray Microscope Design Innovation for Submicron Imaging

Sigray's PrismaXRM™ is a breakthrough 3D x-ray microscope that combines the **submicron high resolution** performance comparable to the leading x-ray microscopes with its unique, unprecedented **multi-contrast capabilities**. The PrismaXRM is the only laboratory system capable of providing Quantitative Phase™ and Subresolution Darkfield™ modes of imaging.

What are the advantages of Quantitative Phase™ and Subresolution Darkfield™?

X-ray absorption contrast microscopy has advanced considerably in the past decade to maturity. Many vendors now providing comparable performance of 0.5 to 1 µm spatial resolution, which is near the limit of lensless x-ray microscopy. The PrismaXRM breaks through these barriers with new imaging modalities that overcome the barriers to conventional imaging.

- With Quantitative Phase™, the first differential of the refractive index is obtained. This provides not only stronger phase information than edge enhancement phase, but also enables **quantitative** results for compositional analysis.
- With Subresolution Darkfield™, features below the resolution (e.g. on the order of 100s nm) such as **crack tips and voids** are seen. Nanoparticle migration and inclusions have also been seen using the PrismaXRM's Darkfield capabilities.



Absorption | Quantitative Phase™ | Subresolution Darkfield™

Tri-Contrast Imaging: Sigray PrismaXRM simultaneously acquires three forms of x-ray contrast: absorption, Quantitative Phase™, and Subresolution Darkfield™. Shown above is a tri-contrast image of a frog's toe joint using the Sigray PrismaXRM; different features are clearly visible in each mode of contrast, such as the spongey tissue using the darkfield and musculature in phase contrast. Tri-contrast imaging has demonstrated powerful capabilities for a range of new applications such as lithium migration in battery samples, hidden cracks in semiconductor packaging, and more.

Empowering Research in...

Materials & Bio	Carbon fiber reinforced polymers (CFRPs), unstained biological tissue (plants and animals)
Energy	Batteries and fuel cells - in operando and in situ
Failure Analysis	Cracks, voids, and delamination previously invisible for x-ray microscopy are now visible using the PrismaXRM's unique Quantitative Phase and Subresolution Darkfield contrasts
In-situ Experiments	Three-phase flow, crack propagation, tensile and loading. Tri-contrast is particularly powerful for in situ.

Prisma-XRM™ Specifications

Parameter	Specification
Dual Modes	Absorption Mode | Submicron resolution at large working distances Tri-Contrast Mode | Absorption, Quantitative Phase™, and Subresolution Darkfield™ acquired simultaneously
Spatial Resolution[a]	Submicron (0.5 µm) in Absorption Mode <3 µm Microns in Tri-Contrast Mode
Source(s)	Sealed Tube Transmission | Additional Patented Sigray Microstructured Source (optional)
Target	Tungsten on diamond substrate | Patented target with microstructured metals embedded in diamond in secondary Sigray source
Voltage	30 - 160 kV
X-ray Detectors	Multiple detector system. Enables rapid changing of FOV and resolution modes
Scintillator-coupled objectives	0.4X, 4X, 20X, and 40X objectives[b], 2k x 2k CCD detector
Large FOV detector	Choice of flat panel detector[c] for increased FOV or photon-counting detector[d] for high throughput for high x-ray energies and energy thresholding. Custom sizes upon request.
Tri-Contrast Design Energy	20, 30, 40[e], and 50 keV[e]
Stage	100 x 100 x 100 mm XYZ High precision air bearing rotary stage with up to 25 kg load
Software	Sigray3D Intuitive Software. Optional ORS Dragonfly and/or Avizo Data Analysis Advanced algorithms for improved reconstruction time and quality

[a] Spatial resolution for absorption mode measured with 2D resolution target, normal field mode, optional 40X objective
[b] 4X and 20X objectives are standard. 0.4X and 40X objectives are optional
[c] Flat panel standard option is 2304 x 2904, with 50 um pixels. Larger formats are available upon request.
[d] Photon-counting detector comes in three formats: 1k x 0.5k at 40 Hz with CdTe, 1k x 1k 100 Hz CdTe, and 1k x 2k 20 Hz CdTe. CdTe enables high efficiency at high energies.
[e] 40 and 50 keV tri-contrast requires optional patented Sigray microstructured x-ray source

Sigray PrismaXRM™ was developed by Dr. Wenbing Yun, a pioneer in XRM and an OSA fellow for his work on x-ray microscopy. The system won the prestigious Microscopy Innovation Award in 2020.

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