Why use X-ray Topography?

The characterisation of crystals or layers deposited on a crystalline substrate can provide insight into their performance for electronic or other applications and help improve their quality.
The ESRF offers a service portfolio of Bragg diffraction X-ray imaging techniques, providing quantitative and qualitative information on defects in single crystals.

TOPO EXPRESS and **TOPO MONOCHROMATIC** are mail-in, rapid and confidential services to reveal the crystalline quality of samples in various forms:

- **Bulk crystal:** defects such as dislocations, inclusions, growth sectors and growth striations, twinning, as well as general distortion (curvature, local mosaic spread)
- **Sub-surface damaged** areas associated with surface processing (cutting, polishing)
- **Overgrown layers:** local mosaic spread, lattice parameter mismatch with respect to the substrate

Service specifications		TOPO EXPRESS	TOPO MONOCHROMATIC		
			RCI Standard	RCI + SECTION	High Resolution RCI
Defect characteristics	Shape of defects	✔	✔	✔	✔
	Location of defects	✔	✔	✔	✔
	Identification of defects	✔	✔	✔	✔
	Quantitative distortion associated with defects		✔	✔	✔
	Quantitative angular misorientation associated with defects		✔	✔	✔
	Density of defects	Qualitative, order of magnitude	Integrated over the thickness	Depth profiling provided	Optimised for thin films
Spatial resolution		10 µm	0.6 µm	0.6 µm	0.1 µm
Max Field of view		15 x 50 mm²	15 x 15 mm²	1.5 x 0.01 mm² section virtual slice	0.01 mm²
Max sample size		120 x 60 mm²	120 x 60 mm²	120 x 60 mm²	10 x 10 mm²
Strain / Effective misorientation sensitivity		10 µrad	1 µrad	1 µrad	sample dependent

Synchrotron X-ray Topography Non-destructive characterisation

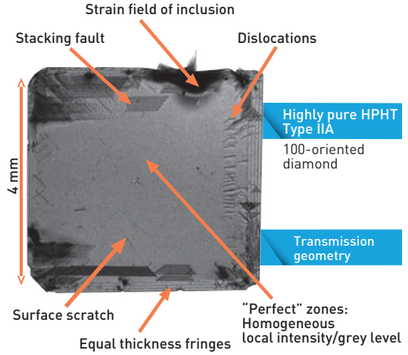
1 TOPO EXPRESS

Polychromatic "White" X-ray beam analysis to provide an overview of defect distribution and qualitative inofrmation on the stress and strain.

TOPO EXPRESS is able to resolve individual dislocations or dislocation densities as high as 10 cm/cm³.

A fast-track service is available starting from 160 € per sample.

Example: White X-ray beam topograph of diamond



2 TOPO MONOCHROMATIC

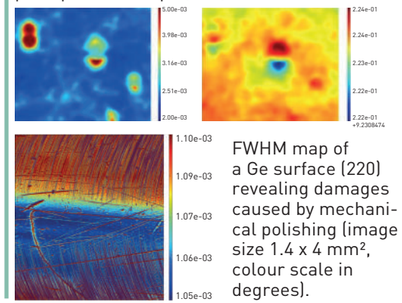
Monochromatic X-ray analysis for accurate and quantitative studies. Defects with a quantitative measurement of the local mosaic spread and local peak position, with spatial resolution in the micron range. The X-ray beam characteristics is chosen according to your needs and sample.

Rocking Curve Imaging (RCI) standard

- 2D strain mapping and defect localisation
- Data integrated over the thickness no depth resolution

Example: Standard RCI on wafer substrates

Images (500x500 µm²) of silicon nitride inclusions as observed on the FWHM and peak position maps (RCI).



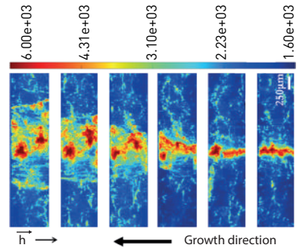
FWHM map of a Ge surface (220) revealing damages caused by mechanical polishing (image size 1.4 x 4 mm², colour scale in degrees).

Rocking Curve Imaging (RCI) + Section

- Standard RCI is combined with **Section Topography**, where the "White" X-ray beam is restricted to image of a virtual slice of the sample, giving improved depth resolution

Example: Section Topography on mono-like silicon solar cells

Six successive "section RCI" images, separated by steps of 0.5 mm, showing clusters of screw dislocations developing along the growth direction of a Si lingot for photovoltaic purposes.

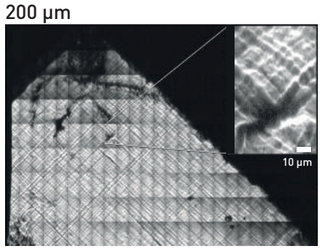


High Resolution RCI

- Diffracted X-ray signal is magnified using dedicated optics to enhance spatial resolution
- Optimised for the characterisation of thin films of significantly lower crystalline quality than bulk samples.

Example: HR Topography of a ferroelectric thin film

High resolution topography of a perovskite film. The image reveal a cross-hatch pattern contrast caused by defect related strain relaxation due to the lattice mismatch between substrate and film.



Key advantages

- Non-destructive analysis requiring little or no sample preparation
- Provides strain maps with large field of view
- High spatial resolution with respect to laboratory equipment
- Possibility to analyse large samples in real time and under operating conditions
- High-throughput and statistical analysis
- Possibility to characterise thin films and to provide depth profiling
- Tunable X-ray energy to select the diffraction conditions most appropriate for your needs
- Possibility to run the experiment in transmission and reflection mode

Can we help you?

Distortions/defects in crystals or overgrown layers for:

- Micro and nano-electronics,
- Detectors
- Photovoltaics
- Crystal growth

Industrial applications

- Single crystals for electronic device application
- Photovoltaics
- Crystal optics for synchrotrons fels and accelerators
- Photonic devices
- Sensor applications

What is PAC-G?

The Platform for Advanced Characterisation Grenoble is a single entry point for commercial services of characterisation and non-destructive analysis, dedicated to the micro- and nano-electronics industry, offered by the European Synchrotron (ESRF), the Institut Laue-Langevin (ILL), the Laboratory of Subatomic Physics & Cosmology (LPSC) and Alternative Energies and Atomic Energy Commission (CEA).

We provide proprietary client services, and we are open to collaborative programmes and partnerships (e.g. Horizon2020 projects).

NANOELEC.

Platform for Advanced Characterisation | PAC-G

Tel: +33 (0)4 76 88 29 05
support@pac-grenoble.eu
https://pac-grenoble.eu

- **Easy**
  - Flexibility, reactivity and customisation
  - Single entry point to access complementary large scale research infrastructures
  - Reactivity
  - Mail-in services
- **Confidential**
  - NDA/CDA and MTA as needed
- **Dedicated staff**
  - World reputed expertise
  - Devotion
  - Experience
- **Dedicated equipment**
  - World class unique characterisation services
- **Tailored to your need**
  - One shot services
  - Long term collaboration agreements
  - Collaborative projects (H2020, PPP)
  - Advice and training

Synchrotron X-ray Topography

Non-destructive analysis

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Platform for Advanced Characterisation | PAC-G

ESRF The European Synchrotron

Express characterisation services at the European Synchrotron

Synchrotron X-ray solutions for high-throughput analysis of electronics components