X-Ray Laue Diffraction Microscopy

Nano- and microscale X-ray characterisation of functional materials and microstructure

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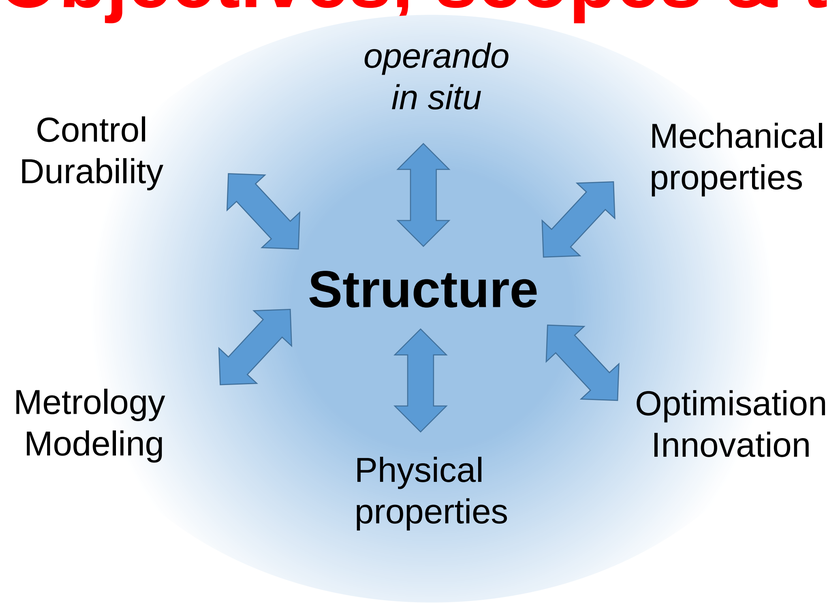
CRG-IF BM32 beamline, Univ. Grenoble Alpes, CEA/IRIG/MEM & SyMMES, CNRS Institut Néel, CNRS SERAS

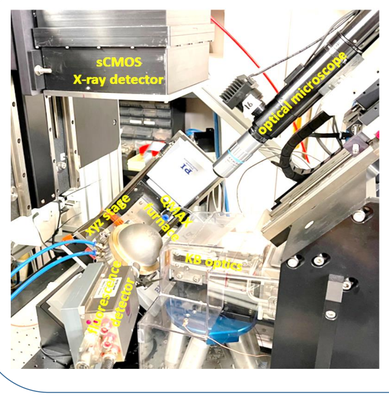
Objectives, scopes & techniques



For
- Materials science, Nanoscience
- Real and model systems
- Microstructure, nano- and microobjects, microdevices
- Fundamental science & technology-related materials

Needs
- Accurate, quantitative experimental data
- Accessible measurements
- Transversal technique (metals, oxide, semiconductors,…)
- Complementary with SEM, TEM

Scanning X-ray white beam microdiffraction



BM32 beamline

- ✓ Dedicated station
- ✓ Unique in Europe
- ✓ Home-dev. software (AI)

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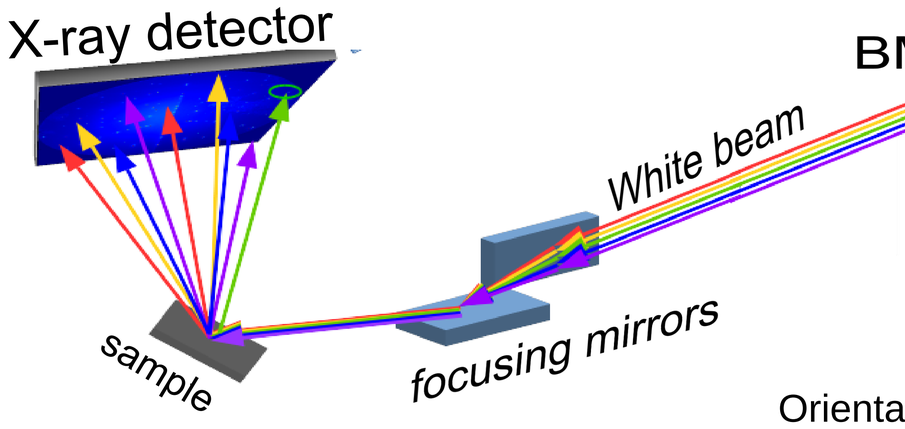
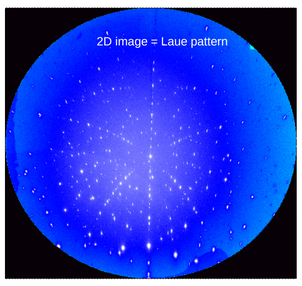
ESRF The European Synchrotron

- ✓ First 4th generation synchrotron
- ✓ Extremely Brilliant Source
- ✓ High Performance Computing

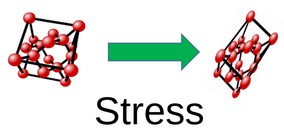




LaueNN
LaueTools
analysis

https://github.com/BM32ESRF/

Orientation
Strain
Lattice parameters



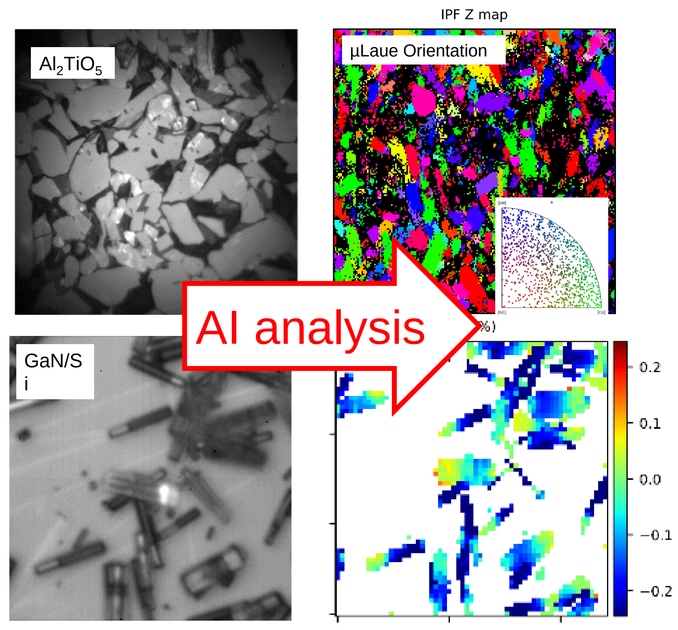
Stress
Defects

Local lattice parameters, strain, orientation, microstructure

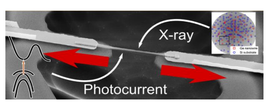
HR spatial: 300 nm x 300 nm
HR angular: 0,006° ⇔ 0,01%

Capabilities
No sample preparation
In situ & operando (T, force, I, V, XEOL,…)
Polycrystalline & single crystal
2D mapping (9000 pts/h)

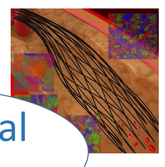
Augmented µLaue
Depth resolution (500nm)
Stress assessment
Extended defects (plasticity)



Applications

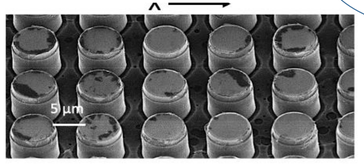


Direct gap strained Ge

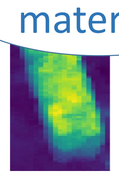


NiTi alloy

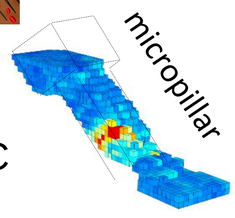
InGaN/GaN µLEDs

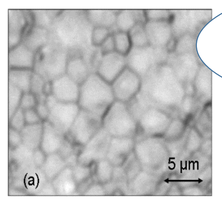


Functional materials



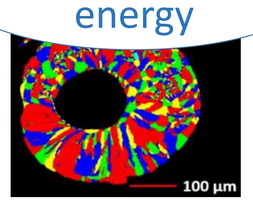
ZrO_2 at 1350 °C



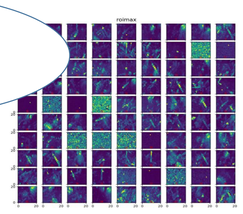


UO_2

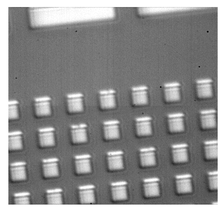
Low-carbon energy



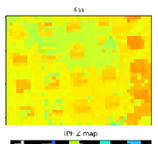
U-Zr-O (corium)

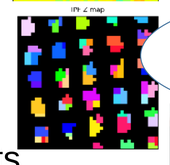


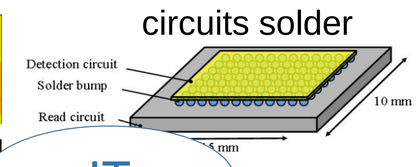
new battery materials



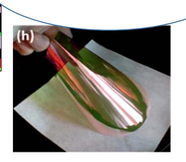
3D interconnects







IT



Flexible microelectronics

Perspectives

More throughput **More automation** **More dimensions** **More resolution** **More complexity**

- ➢ PIA3 MAGNIFIX upgrade: LaueMAX
  State-of-art X-ray optics, flexible & efficient instrumentation
  Full performance + Open to users: Spring 2024
- ➢ PEPR DIADEM: automated platform for materials science
  Screening & high-throughput
  Machine Learning Assistance: Data collection & Analysis

PTC : DALLIAE beamline automation with IA DES/ISAS/DM2S
PTC: MapgrainXL complex materials+IA DES/ISAS/DRMP
CFR phD: serial Xtallography + materials for photonics