Key advantages

- Dedicated world-class staff for fast responses and outstanding results
- Extensive expertise working with industry demands
- Most powerful synchrotron X-ray and neutron beams in the world, available at one place Phase contrast and absorption contrast imaging
- techniques available as needed Possible to develop specific sample environmen-ts to perform in-situ and in-operando investiga-tions
- World record spatial resolutions for synchrotron X-rays (30 nm) as well as neutrons (4 µm, with a field of view about 3mm) mized and simpler sample preparation Possible to combine neutrons and X-rays for characterisation studies in the micrometer range
- Possible to follow light elements inside heavy materials and to use isotope contrast differentia-tion if needed.

Can we help you?

2D/3D visualization of defects and dynamic phenomena for:

- Micro- and nano-electronics
- Sensors, MEMS and advanced devices
- Packaging, interconnections and metallizations
- High reliability systems and PCB
- Non-destructive investigations

Industrial applications

- MEMS and sensors in-operando testing
- New product and process validation
- System in Package (SiP)
- Visualisation of complex heterogeneous structures
- Analysis of failure mechanisms

What is PAC-G?

The Platform for Advanced Characterisation Grenoble is a single entry point for characterisation services 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
- Multidisciplinary team
- World renowned expertise

Dedicated equipment
- World class characterisation facilities

Tailored to your need
- One shot services
- Long term collaboration agreements
- Collaborative projects
- Advice and training

Synchrotron X-ray and Neutron Imaging

Non destructive failure analysis

Credits: P. Jayet/ESRF

NANOELEC.
Platform for Advanced Characterisation | PAC-G

Synchrotron and neutron 3D imaging

Outstanding non-destructive tomography and radiography services for failure analysis and reliability studies

2D and 3D imaging for microelectronics

PAC-G provides access to a unique set of state-of-the-art imaging instruments and beamlines offering world record time and spatial resolution. At the PAC-G, companies can perform qualification tests, reliability studies and failure investigations non-destructively, thanks to the very high brilliance and power of the X-ray and neutron beams available at the ESRF and ILL. ESRF's and ILL's staff have unique expertise and commitment to answer industrial demands in a fast and high-quality manner. With their support, specific sample environments can also be developed for in-situ and in-operando tests. A high flexible experimental setup and a variety of ancillary equipment are available.

Main applications include process and product development, yield enhancement studies, failure analysis and applied R&D.

The unmatched capabilities of PAC-G facilities allow characterisations in the whole semiconductor value chain, from materials to fully-packaged devices, including multilayer circuit boards and electronic systems.

	PAC-G IMAGING SERVICES			
Service specifications	Micro-Tomography	Nano-Tomography	Ultra-fast Radiography	Neutron Tomography
Provider	ESRF	ESRF	ESRF	ILL
Probe	synchrotron x-rays, energy up to 20 keV	synchrotron x-rays, energy up to 33 keV	synchrotron x-rays, energy up to 20keV	Cold neutrons, average energy 25meV and lab source X-rays
Best resolution	300 nm	30 nm	300 nm	4 µm
Phase contrast	✔	✔	✔	
Max field of view	100 x 500 mm²	400 x 400 µm²	100 x 500 mm²	170 x 170 mm²
Max sample size (*)	30 x 30 x 50 cm³	Few nm	30 x 30 x 50 cm³	Up to 1 m
In operando characterisation	✔		✔	✔
Typical access time	1 month	1 month	1 month	1 month

(*) depending on the constituent materials and geometry of the sample as well as test resolution

Synchrotron X-ray imaging

Synchrotron X-ray 2D and 3D imaging beamlines of the ESRF offer ultra-high spatial and time resolutions to observe the inner details of complex structures in the nanometre and micrometre ranges. The use of phase-contrast imaging can also provide higher contrast information making it possible to identify different materials and features.

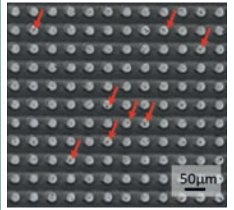
X-ray micro-tomography

With real spatial resolutions down to 400 nm, it is an ideal technique to detect defects non-destructively within a packaged device. Ultra-fast radiography allows the observation of ultrafast dynamic phenomena (track of explosions, shock waves and crack propagation etc.) with a time resolution from few µs to hundreds of ps.

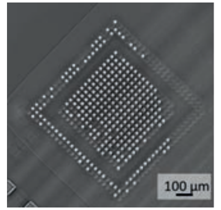
Example:

Packaged chips

The unique features of synchrotron X-ray micro-tomography allow scanning fully encapsulated packaged devices non-destructively for the studies of failure mechanisms and R&D.



Slice image acquired from a flip-chip showing the interface between two dies. We can observe copper pillars in white and defects as black dots (some are highlighted by red arrows).



Slice of a similar copper pillar stack. Image reconstructed from laminography measurements.

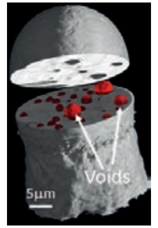
X-ray nano-tomography

For higher resolution, nano-tomography is also available for FoV up to 400 µm. In this configuration, world record 30 nm spatial resolution can be achieved (with 10 nm pixel size) thanks to advanced X-ray optics and a extremely high-brilliance beam focused down to the nanometre scale.

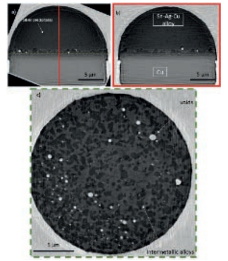
Example:

3D integration

In advanced microelectronics copper pillars are used to stack dice in 3D structures. This creates a real challenge to standard techniques. X-ray nano-tomography is a powerful means to inspect these 3D structures with very high resolution and with no damage to the sample.



Characterisaiton of voids inside a copper pilar



Neutron imaging

Neutron imaging is a powerful technique for the study of electronic components and systems. As neutrons do not have any electrical charge, they can penetrate deeply into matter allowing bulk characterisation. Neutrons interact strongly with light elements and are very effective to detect them, in particular H, B and Li. Neutron imaging can be used to characterise all samples where H needs to be detected, in particular water/moisture contamination of materials and packaged devices. Another unique feature of neutron imaging is the possibility for isotopic differentiation, which allows to increase contrast information and detect the behaviour of subsets of the same element withouth the need for dopants.

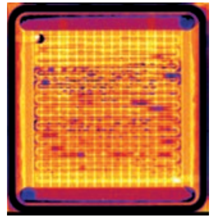
Neutron micro-tomography

Thanks to the very high flux provided by ILL's neutron source and the ample space available at the instrument's casemate, in-situ characterisation studies are possible with real spatial resolution from 100 µm up to 4 µm, with FoV up to 170x170 mm². Moreover, PAC-G offers an ever increasing range of equipment for hydro-chemo-mechanical testing.

Example:

Following water

Applications include detecting water contamination and tracing fluids inside a package, for MEMS, sensors or microfluidic devices for example. The images below illustrate this feature.

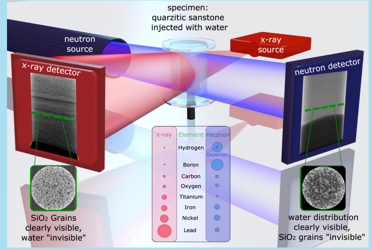


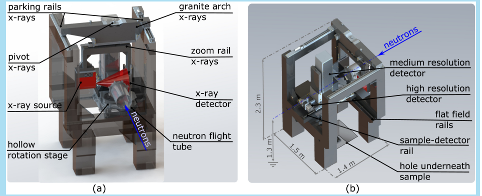
Part of the vapor generated as a byproduct in a fuel cel conden-ses into liquid water. Courtesy A.Morin CEA-Grenoble

+ Complementary service

Combined neutron and X-rays imaging

The neutron tomography station available at ILL also allows to take complementary X-ray images from the same sample, at the same time using a lab X-ray source.
The instrument permits to accommodate large testing equipment and the structure is designed to support equipments up to several hundreds of kilograms.





(a) (b)