Combined Synchrotron n-CT and Small Angle Neutron Scattering Characterisation Applied to Reliability and Yield Enhancement for Microelectronics

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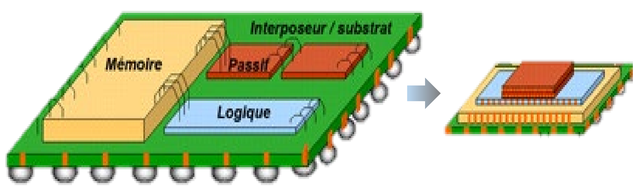
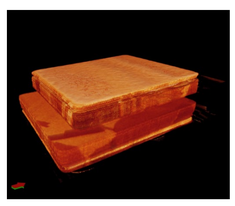
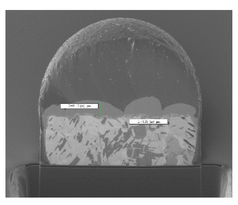
Motivation: 3D Integration Challenges



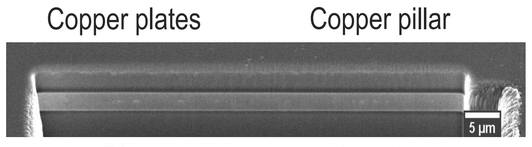
The principle of 3D integration



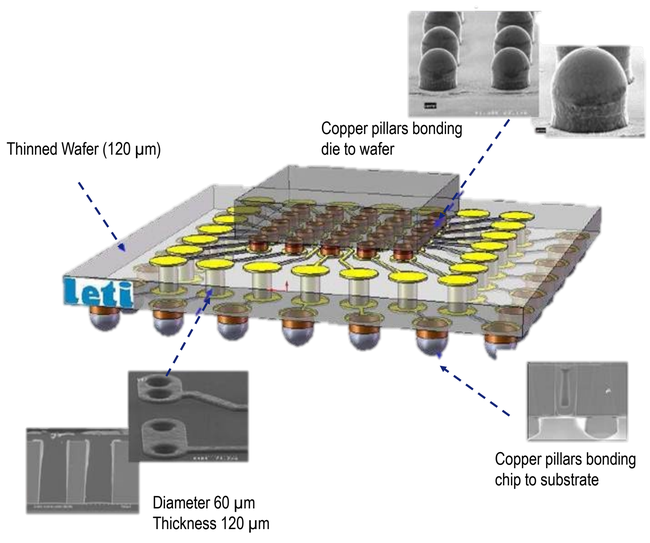
Copper plates



Copper pillar



Direct copper-copper bonding

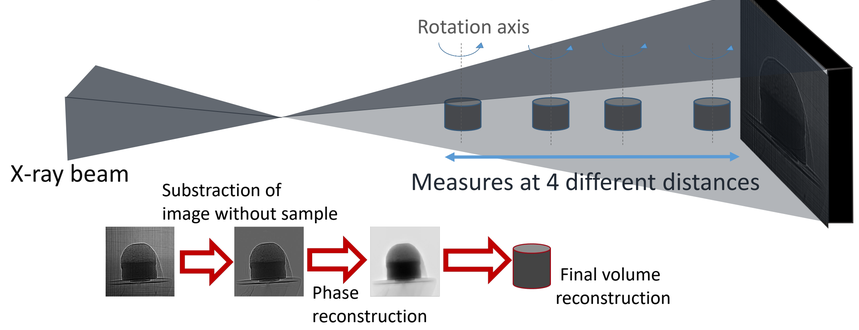


Objectives

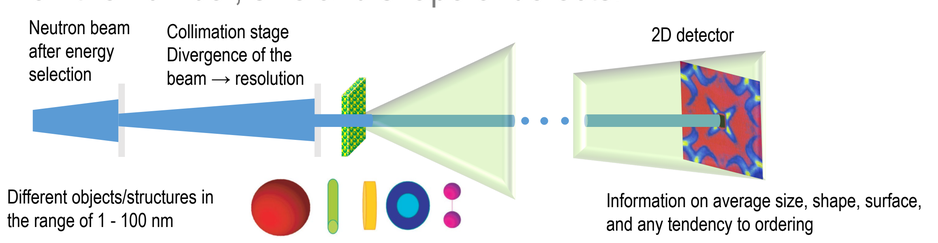
- To provide high quality local (sub 50 nm) as well as statiscal information on defects appearing on complex structures like copper pillars
- To understand and predict failure mechanisms in advanced packaging technologies

The Techniques

Synchrotron X-ray Nanotomography at beamline ID16A at the **ESRF** allows to characterise the morphology of one or several samples with spatial resolution up to **30 nm** (10 nm pixel size)

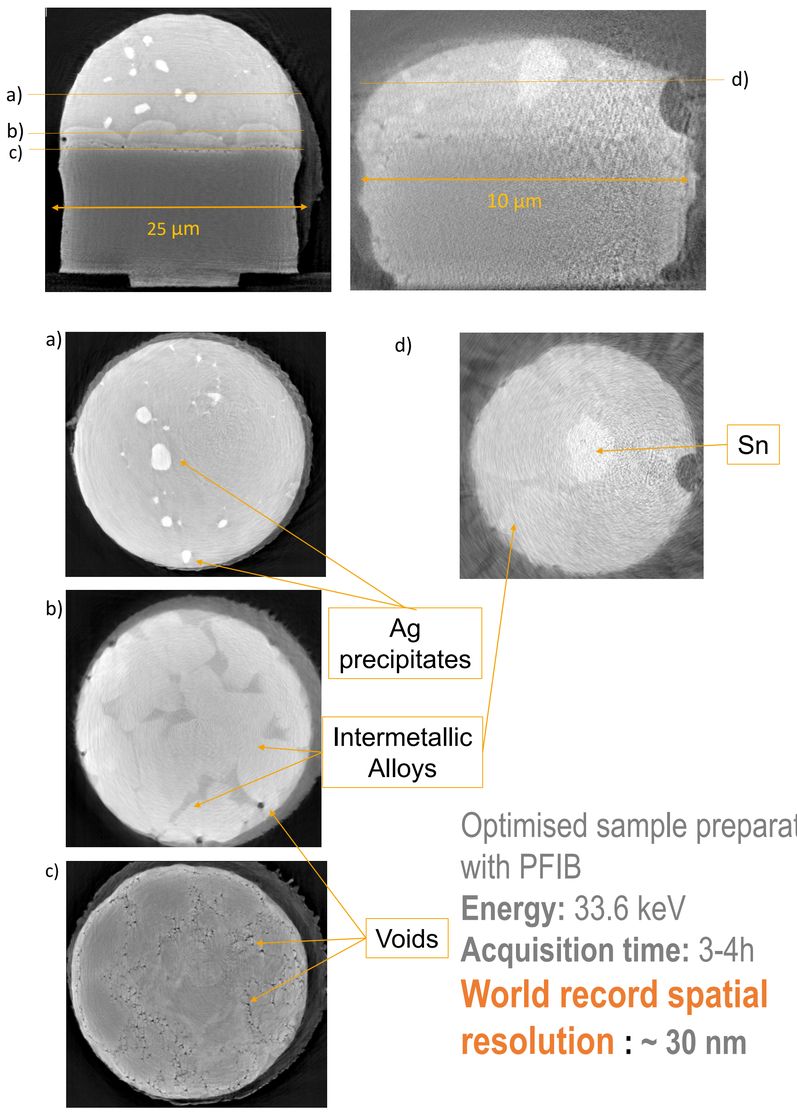


Small Angle Neutron Scattering (SANS) at **ILL** allows to characterise nanometric defects inside a matrix, giving **quantitative** statistical information on the number, size and shape of defects.



Effectively Combining Advanced Characterisation Techniques: Results and Discussion

Synchrotron X-ray Nanotomography

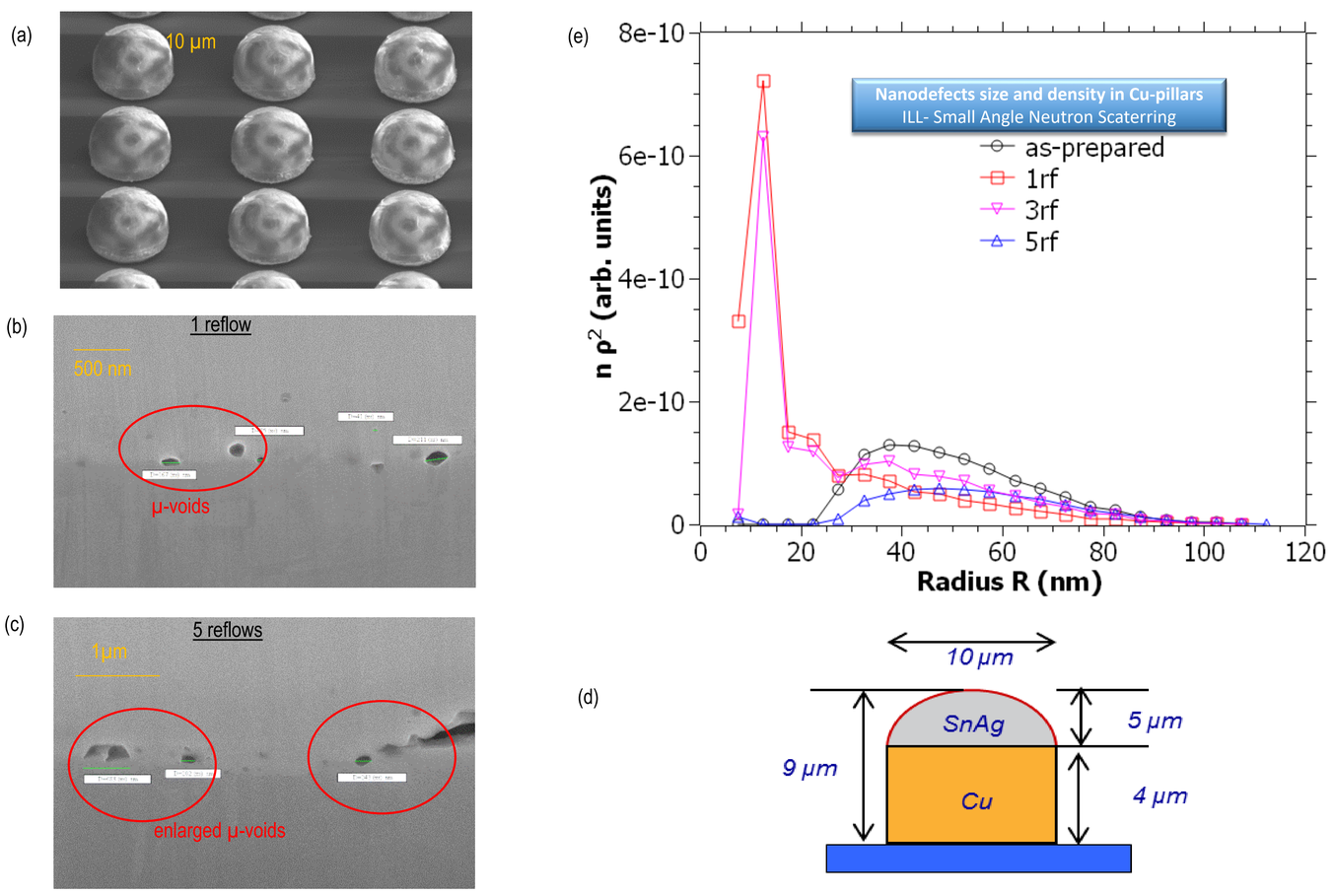


Optimised sample preparation with PFIB
Energy: 33.6 keV
Acquisition time: 3-4h
World record spatial resolution : ~ 30 nm

Ref: A.Fraczkiewicz et al., 3D high resolution imaging for microelectronics: a multi-technique survey on copper pillars, Ultramicrosopy 2018 Oct;193:71-83. doi: 10.1016/j.ultramic.2018.04.012

Statistical Characterisation Using Neutron Scattering Technique

We demonstrated SANS unique capability to provide statistics on nanodefects in a complete set of copper pillars characterised locally by X-ray nanotomography.



(a) Cu-pillars showing the patterning obtained by X-ray tomography, voids defects after one reflow (b), after 5 reflows (c). (d) shows a scheme of the stack of the Cu-pillar on which on SANS measurements have been performed. (e) SANS analyses show an evolution in the size and number of micro-voids as a function of the number of reflows.

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