

# Multi-scale X-ray computed-tomography for the 3D detection and location of nanomaterials in manufactured materials and complex media

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## Abstract:

X-ray computed tomography (CT) is a powerful 3D imaging technique for the in-situ and non-destructive investigation of the inner structure of an object. This relatively recent technique has tremendously evolved over the past decade with much more sensitive detection systems and increased spatial resolution. Indeed it is now possible to reach spatial resolution of tens of nanometers with synchrotron X-ray source but also with lab-based systems (called nano-CT). Reaching such high spatial resolution made CT a valuable technique for the 3D detection and location of nanomaterials, their aggregates and agglomerates (NOAA) in manufactured materials (wood coating, polymers ..) and in complex and/or natural media (plants, organisms, organs ...).

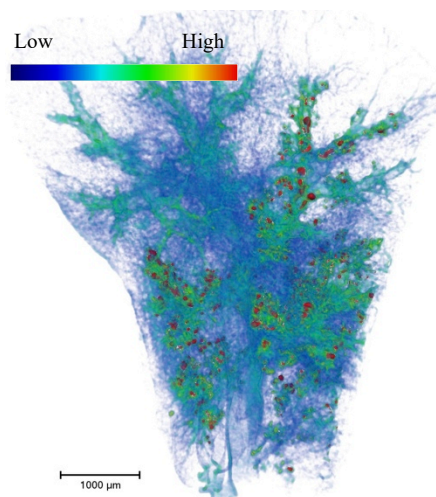
The Nano-ID<sup>1</sup> platform, installed at CEREGE (Aix en Provence, France), is equipped with two CT systems and offers the opportunity to perform multi-scale analysis on a same sample, i.e. 3D imaging with a spatial resolution ranging from 50  $\mu\text{m}$  to 50 nm.

For example, in a study focusing on the aging of wood-coating containing  $\text{CeO}_2$  nanomaterials and associated NOAA released, multi-scale micro and nano-CT gave the keys to identify NOAA distribution in non-aged materials and their behavior during aging. In the field of "safer-by-design" production or eco-conception, the accurate distribution of NOAA and their residues in complex matrixes is of particular interest to understand the the consumers and environmental exposure.

We also demonstrated the relevance of multi-scale micro-CT (down to submicron-scale) to detect and locate  $\text{CeO}_2$ -based NOAA within soft tissues (e.g. mouse lung tissues) after in vivo exposure and artefact-reduced sample preparation procedure. This capability is gaining interest especially since the scientific community

cautiously address the potential risk of NOAA for humans and living organisms.

**Keywords:** micro and nano-CT, multi-scale 3D imaging, in-situ and non destructive technique, nanomaterials, their aggregates and agglomerates (NOAA), wood coating aging, release mechanisms, biodistribution, soft tissue, lung architecture.



**Figure 1:** 3D image of a lung lobe of mouse exposed to  $\text{CeO}_2$  nanomaterials obtained by micro-CT (voxel size of 14,32  $\mu\text{m}$ ). Dense nanonanomaterials are false-colored in red.

## References:

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