Quantitative and chemical nanoimaging of heterogeneous materials by ptychographic X-ray computed tomography

Julio Cesar da Silva[1,2,3] & FAMEPIX collaboration

[1]Univ. Grenoble Alpes, CNRS, Grenoble INP, Institut Néel, 38000 Grenoble, France
[2]French CRG beamline FAMEPIX, 38000 Grenoble, France
[3]Unité GDR2116 Coherex, 75060 Paris, France
Courriel : julio-cesar.da-silva@neel.cnrs.fr

Catalysts, batteries, ecological building materials, and recyclable composites are heterogeneous materials that address significant societal challenges. Biological materials like cells and tissues also fall into this category. The arrangement of material phases within their 3D structures greatly influences their properties. High sensitivity and nanometric resolution in visualizing these structures can enhance our understanding and improve engineering. Despite advancements in synchrotron techniques, characterizing these complex materials remains challenging. However, coherent X-rays at synchrotron facilities can aid in this process. Ptychography is an innovative holographic imaging technique using coherent X-rays for material characterization *(da Silva, et al. 2015a)*. Ptychographic X-ray computed tomography (PXCT) allows for reconstructing quantitative three-dimensional images of heterogeneous materials, revealing the localization and composition of each material phase without supplementary measurements *(da Silva, et al. 2015b, Ihli et al. 2017, Cuesta et al. 2017)*. When paired with spectroscopic techniques, it further investigates chemical element distribution and magnetic properties (*Kulow et al. 2024, Boudjehem et al. 2024)*. This presentation will highlight various applications, including analyzing catalyst structures in the oil industry *(da Silva, et al. 2015b, Ihli et al. 2017)*, the quantitative characterization of hydration products in ecological cement pastes *(Cuesta et al. 2017)*, and examining metallic alloys for aerospace *(Gussone et al. 2020)*. Additionally, we will introduce FAMEPIX, the new F-CRG beamline that will provide PXCT with spectral capabilities, opening up new opportunities for characterizing heterogeneous materials.

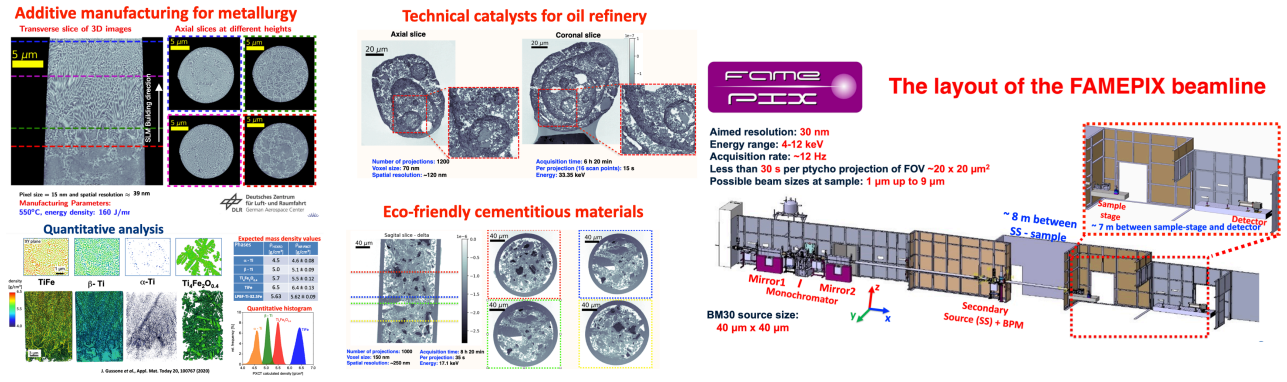

Figure 1: (Left) Some examples of applications of PXCT. (Right) The Layout of FAMEPIX beamline

1) J. da Silva et al., Opt. Express, **2015a**, 23, 33812-33821.
2) J. da Silva et al., ChemCatChem, **2015b**, 7, 413-416.
3) J. Ihli et al., Nat. Communications, **2017,** 8, 809.
4) J. da Silva et al., Langmuir, **2015c**, 31, 3779-3783.
5) A. Cuesta et al., J. Phys. Chem. C, **2017**, 121, 3044-3054.
6) A. Kulow et al., J. Synchrotron Rad., **2024**, 31(4), 867-876
7) R. Boudjehem et al., J. Synchrotron Rad., **2024**, 31(2), 399-408.
8) J. Gussone et al., Appl. Mater. Today, **2020**, 20, 100767.