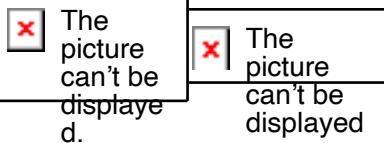


Marianne Liebi– Material Science at Large Scale Facilities

Coherent Diffraction Imaging

EPFL Master Course 2024 MSE435





Unstained human brain tissue

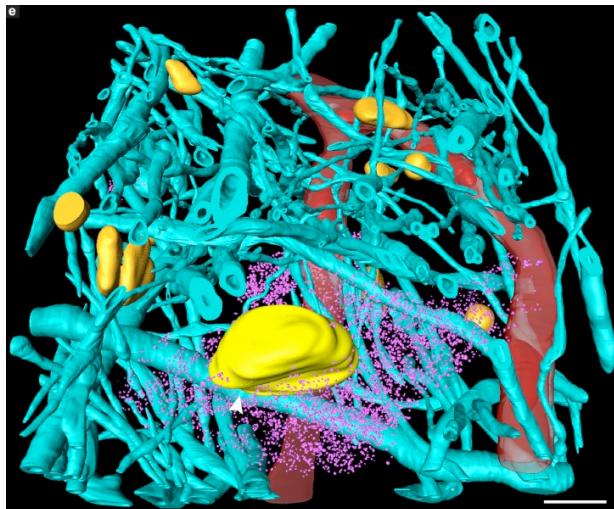
Brain region: substantia nigra pars compacta

Tran, H. T. *et al.*

Front. Neurosci. **14**:570019.

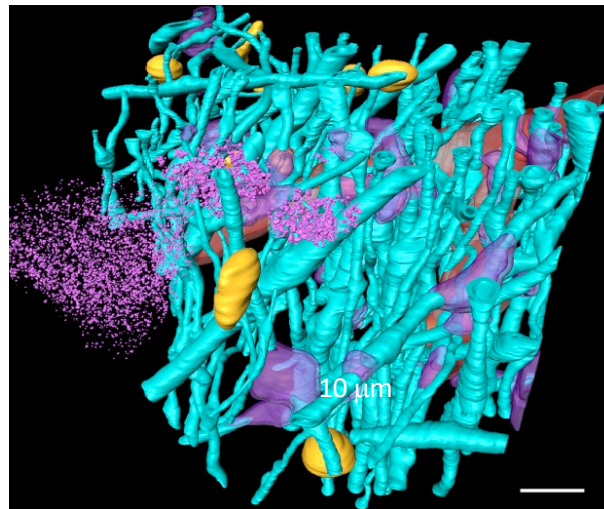
Chemically fixed, hydrated, unstained

healthy



5 specimens imaged from a healthy individual as control

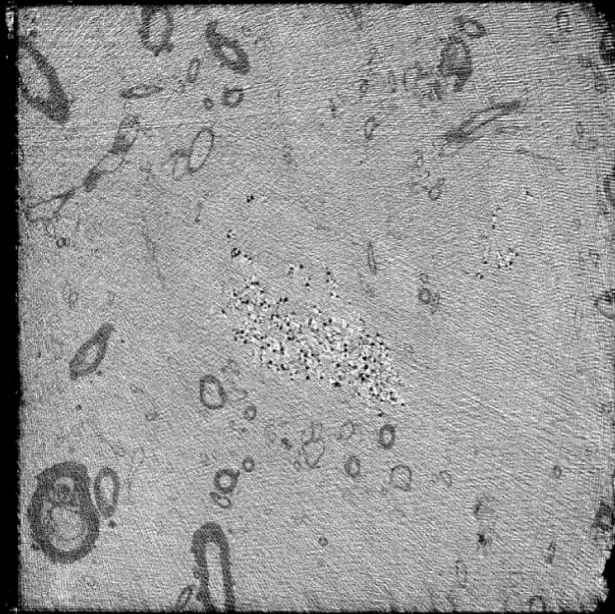
Parkinson-affected



4 specimens imaged from a Parkinson-affected individual

Myelinated axons
Swellings along axons
Cell nuclei
Neuromelanin-containing organelles
Blood vessels
Blood cells

Unstained human brain tissue



Tran, H. T. et al.
Front. Neurosci. 14:570019.

Myelinated axons
Swellings along axons
Cell nuclei
Neuromelanin-containing
organelles
Blood vessels
Blood cells

25 μ m

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3D network structure of methal carbides in Ni supperalloy

synchrotron X-ray CT

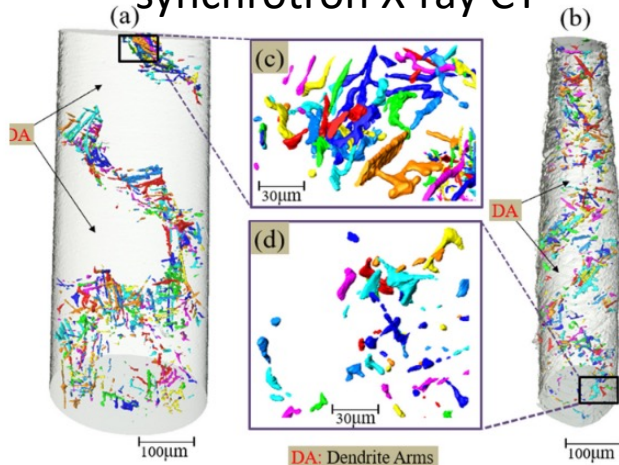
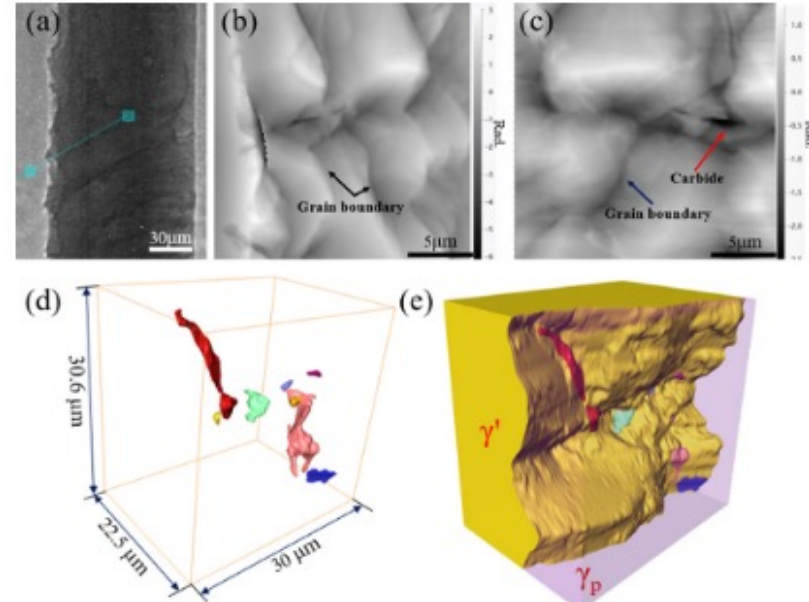


Table 3. The statistic results for different category carbides.

Cooling rate K/s	Carbides		Spherical Carbides		Rod Carbides		Network Carbides	
	Volume (µm ³)	Volume Fraction (%)	Volume (µm ³)	Number	Average Size (µm ³)	Volume (µm ³)	Number	Average Size (µm ³)
0.27	64658	1.04	8345	663	13	39592	426	93
1.12	35090	1.18	6355	463	14	24726	281	88

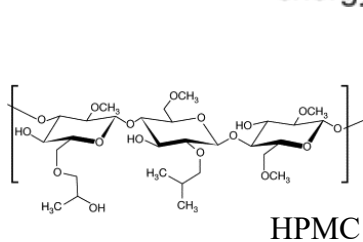
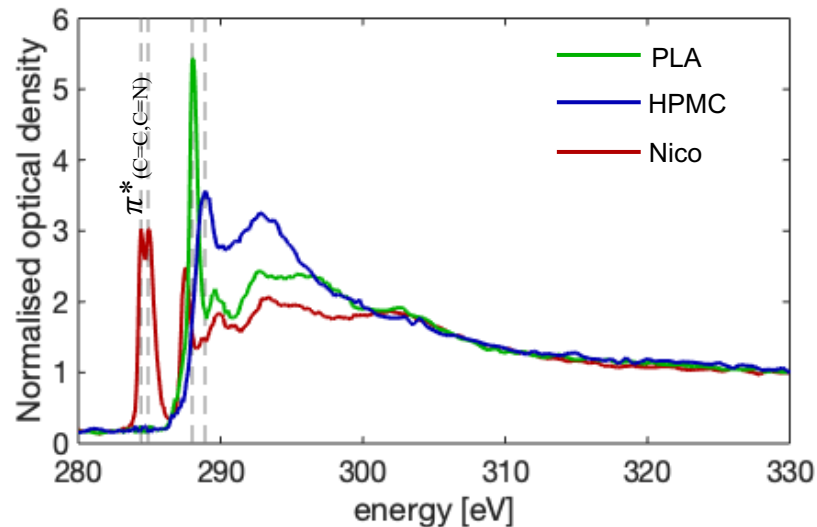
different morphologies

ptychographic tomography

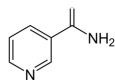


30nm spatial resolution and correlation to different phases
metal carbides mainly on the grain boundary

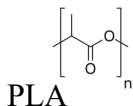
STXM-XANES: Imaging with chemical contrast



HPMC

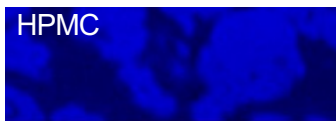
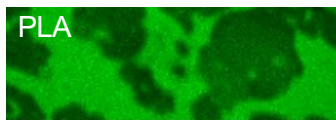
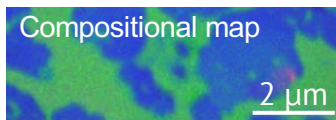


Nicotinamide

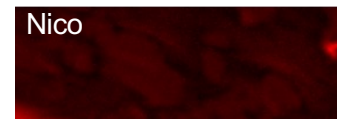
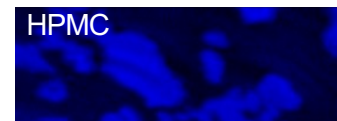
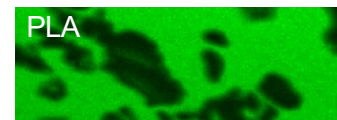
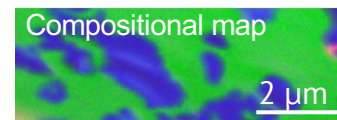


PLA

10wt% nico in 50/50 PLA/HPMC



10wt% nico in 70/30 PLA/HPMC



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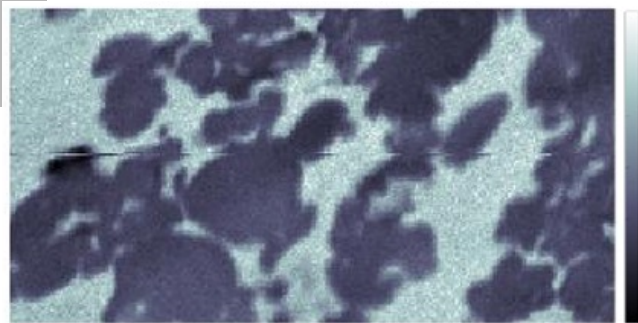
The picture can't be displayed

STXM-XANES imaging with chemical contrast

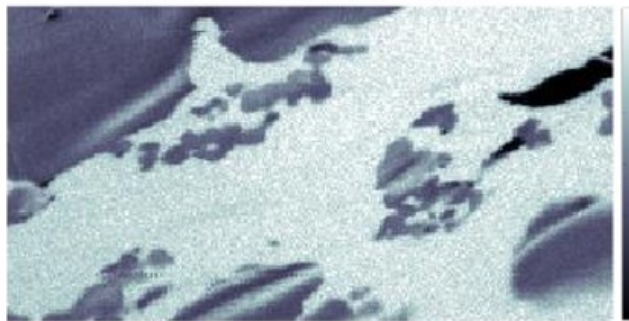
Phase contrast Nanotomography

10wt% Nicotinamide
in 50/50 PLA/HPMC

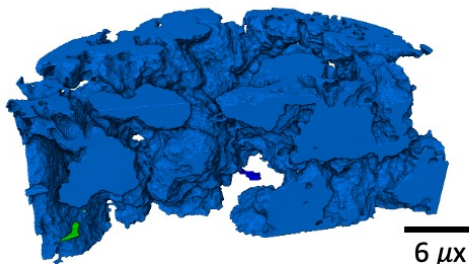
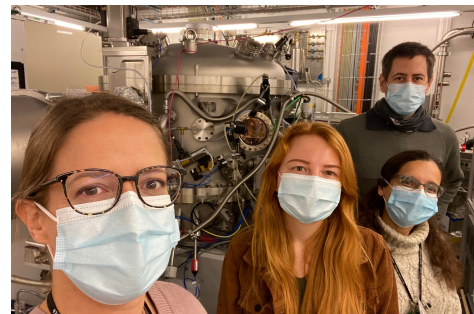
10wt% Nicotinamide
in 70/30 PLA/HPMC



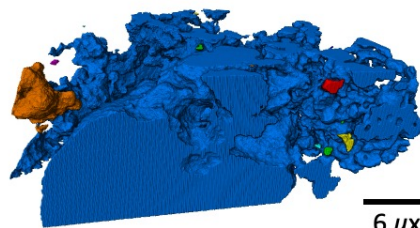
5 μm



5 μm

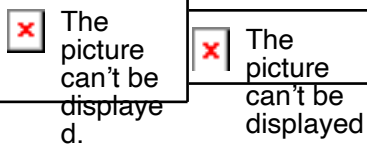


6 μm

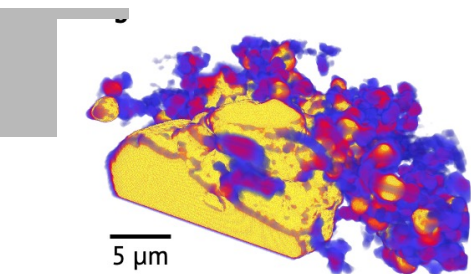


6 μm

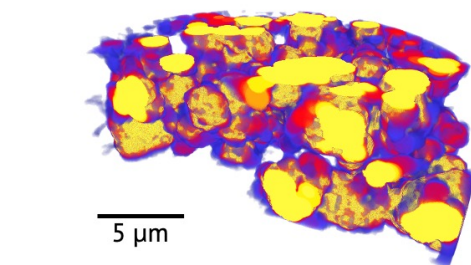
Olsson, M., Nilsson, R. Björn, L. Lilja, V., Krupnik, L. Chen, Y, Naidjonoka, P. Diaz, A., Holler, M., Watts, B., Larsson, A., Liebi, M. , Matic A. *Commun Mater*,2024 5(1), 231.



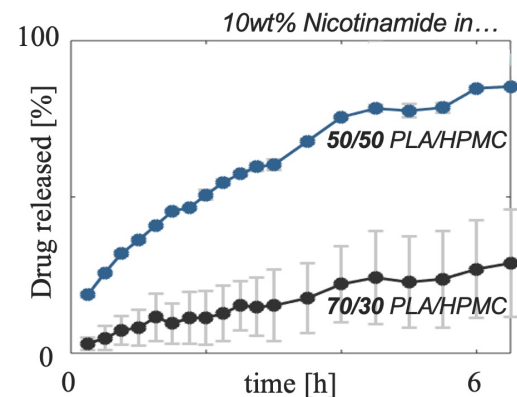
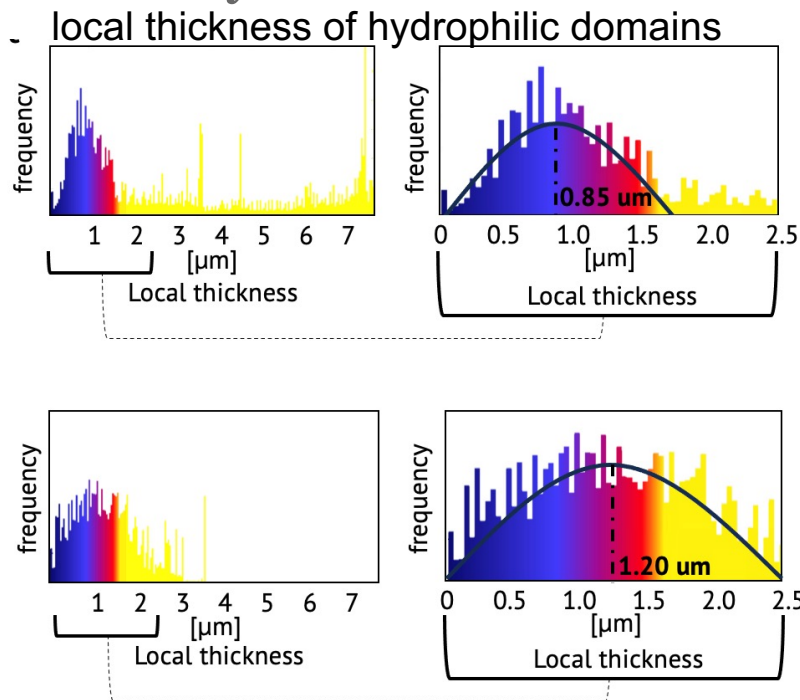
Phase contrast Nanotomography to study connectivity



10wt% Nicotinamide
in 70/30 PLA/HPMC



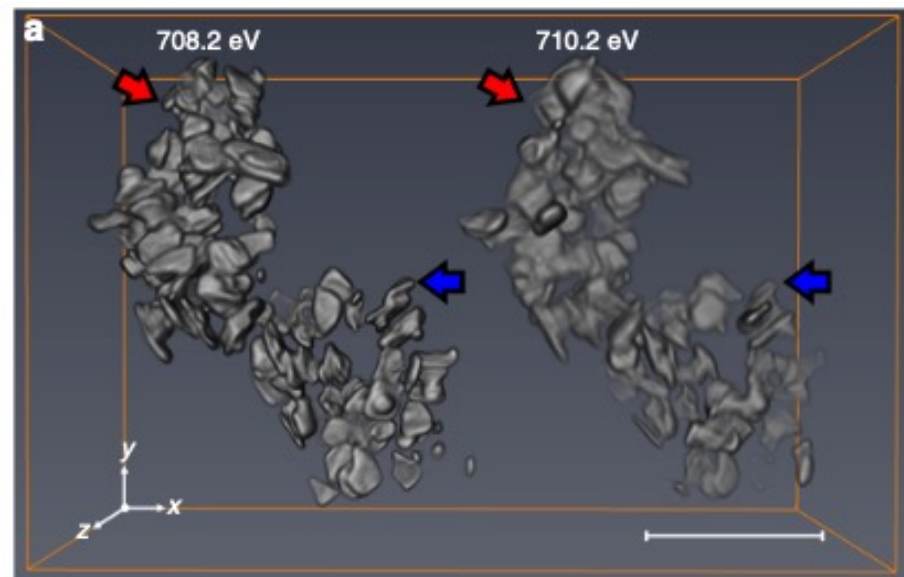
10wt% Nicotinamide
in 50/50 PLA/HPMC



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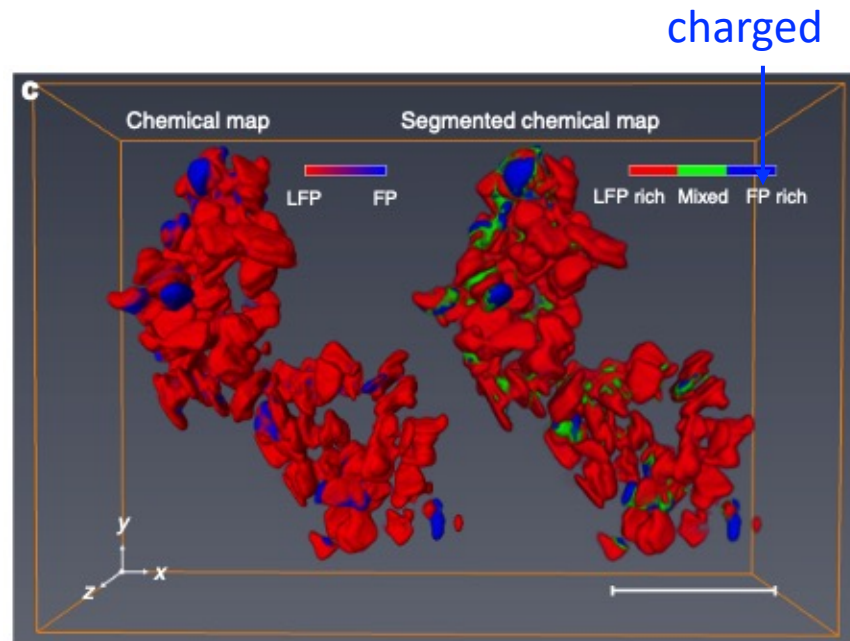
Battery: soft X-ray ptychography combined with spectroscopy



near the Fe L3 edge measured one tomogram at at 708.2 eV (left) and one at 710.2 eV (right)

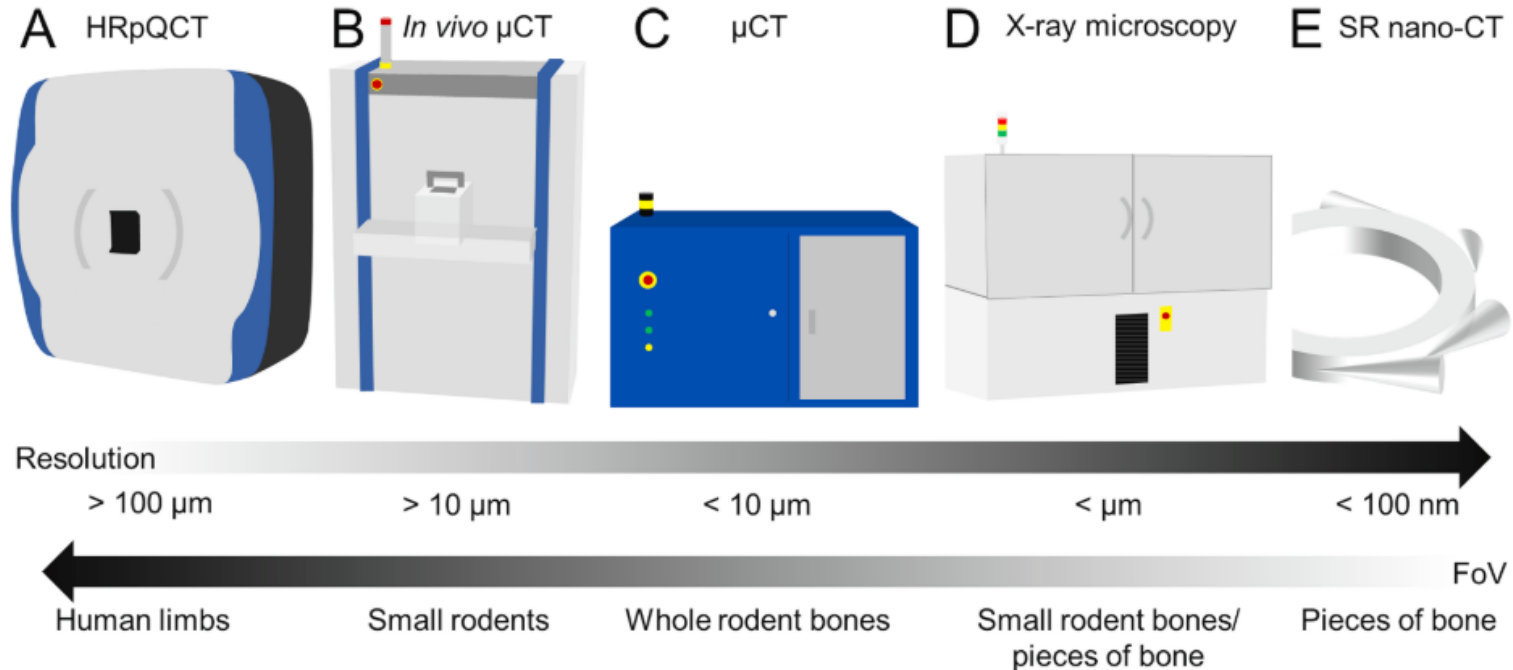
scale bar 500 nm (resolution 11nm)

Yu, YS., *et al.* Three-dimensional localization of nanoscale battery reactions using soft X-ray tomography. *Nat Commun* **9**, 921 (2018).



the 3D morphology and oxidation states of transition-metal cations in agglomerated cathode nanoparticles of lithium iron phosphate (LiFePO_4)

Bone: hierarchical imaging with different methods



Kølln Wittig, N., et al. (2021). Opportunities for biomineralization research using multiscale computed X-ray tomography as exemplified by bone imaging. *Journal of Structural Biology*, 2141, 07822.

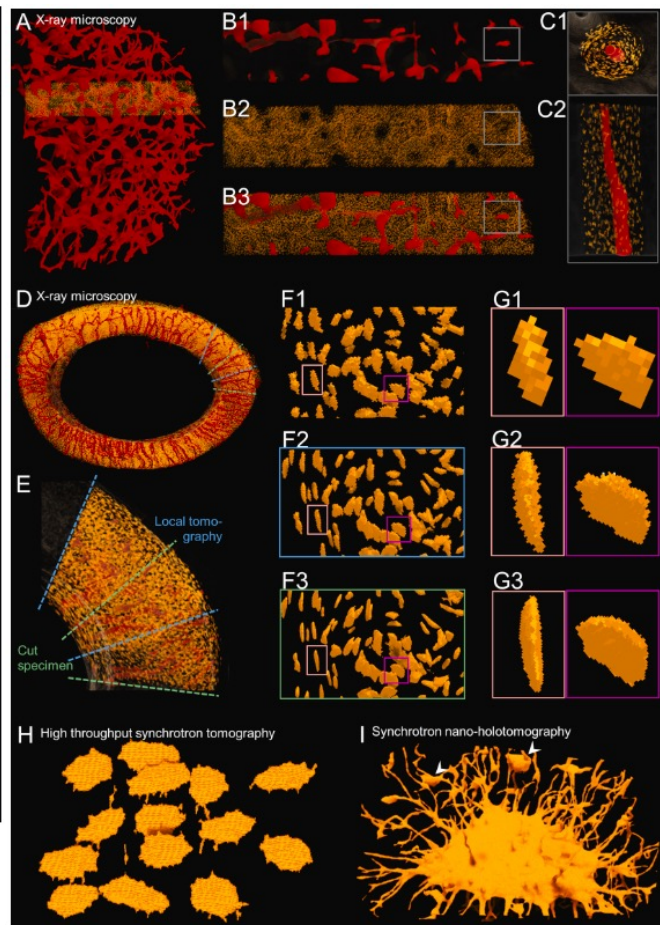
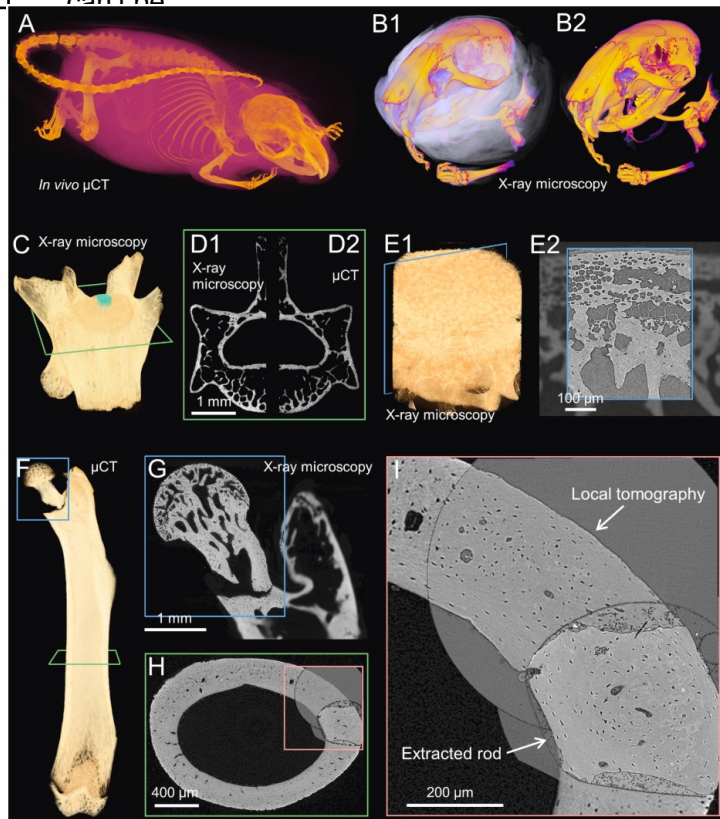


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Bone: High resolution imaging



Kølln Wittig, N., et al. (2021). *Journal of Structural Biology*, 214, 107822.

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Bone: High resolution imaging

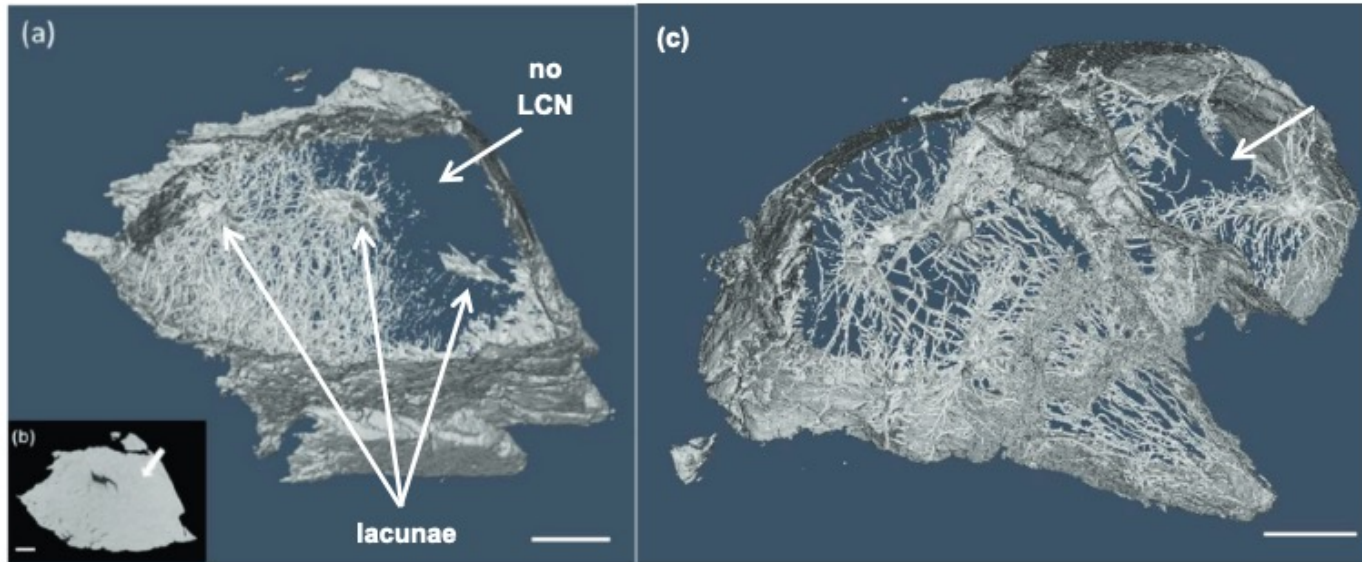


Fig. 7. (a) An image of the segmented LCN showing, indicated by a white arrow, approx. $(10 \times 20 \times 40) \mu\text{m}^3$ region with absent canaliculi, surrounded by isolated, disconnected lacunae, in an example from the GIO group; (b) a tomogram slice in this region confirms the absence of canaliculi, with a featureless matrix region highlighted by a white arrow; (c) shows another GIO group sample with a region containing no canaliculi. The white scale bar in each image represents $10 \mu\text{m}$.

Ciani, A., et al. (2018). Ptychographic X-ray CT characterization of the osteocyte lacuno-canalicular network in a male rat's glucocorticoid induced osteoporosis model. *Bone Reports*, 9(July), 122–131.

The picture can't be displayed.

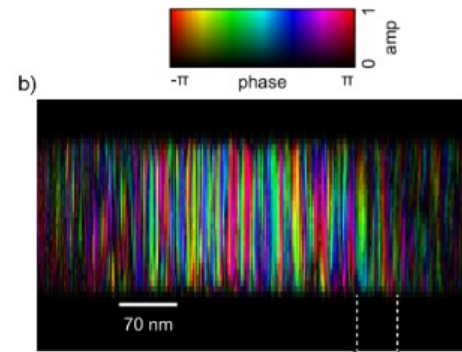
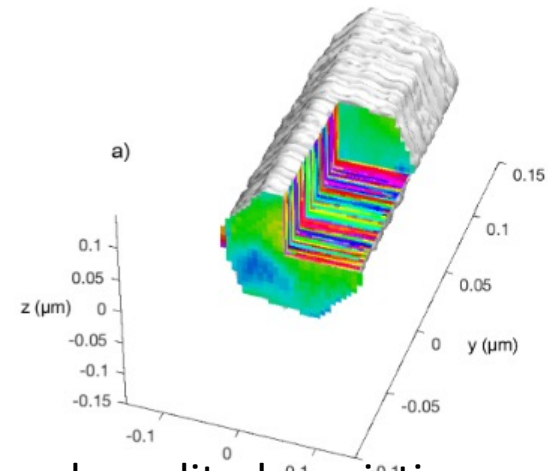
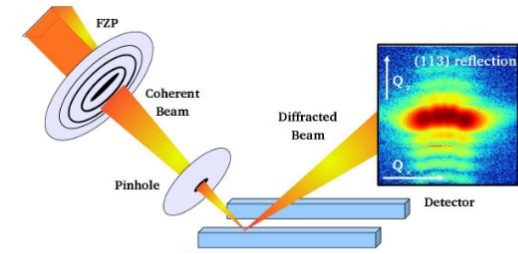
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Nanowires: Bragg CDI

for crystalline structure: far-field diffraction pattern for a chosen Bragg reflection

→ amplitude and phase retrieval, gives access to the strain field

characterize stacking defects and strain in a single InGaAs nanowire



phase and amplitude variations

sharp planar boundaries between different crystal phases of wurtzite

Hill, M. O., et al . (2018). Measuring Three-Dimensional Strain and Structural Defects in a Single InGaAs Nanowire Using Coherent X-ray Multiangle Bragg Projection Ptychography. *Nano Letters*, 18(2), 811–819.