INDUSTRIAL DEVLOPMENT PROJECTS

Making Nano-XRF Accessible for Industrial Lung Tissue Elemental Analysis.

THE INDUSTRIAL CHALLENGE

Lung diseases usually display a very complex pathology and thus a distorted lung physiology. To study the lung and others organs in the body, research is built on the observation of many diverse biological features including the changes in the spatial distribution of elements. The company TrulyLabs needs to assess metal accumulation and spatial distribution in lung cell population residing within fibrotic niches of a chronic bleomycin-induced fibrosis model. This requires both sufficient and resource efficient analytical tools.

WHY USING A LARGE SCALE FACILITY

Mapping of biogenic elements and metals with nanometric image resolution requires a hard X-ray nanoscale probe, similar to those found at fourth-generation hard X-ray synchrotron facilities (ESRF ID16B). Standard laboratory methods can show tissue structure or specific proteins, but they often miss how and where biologically relevant elements are in the tissue. Nanometric X-Ray Fluorescence (nano-XRF) can fill this gap by mapping elements such as iron, calcium, zinc, sulphur and phosphorus directly in tissue samples without any labelling.

HOW THE WORK WAS DONE

Mice lung tissue samples from two points of advance in fibrosis pathology were prepared according to a protocol (presented in Falcones et al. (2025) Cell Commun Signal). With the help of methylene blue and massons thrichrome stained samples, 16 regions of interest (90x90 µm) were selected and raster scanned with 200 nm of step size at 10 keV of energy during two days at the diffraction station of the NanoMAX beamline of MAX IV . The sum spectra was fitted using the PyMCA software and an XRF reference sample (RF-C00-X, AXO-Dresden, DE) to obtain concentration maps of the relevant elements mentioned before. To define spatial context of relevant proteins, another adjacent tissue section was multiplexed immunofluorescence labelled for eight cell markers depicting epithelial cells AT1 and AT2, diverse immune cells and fibroblasts populations. Apart from analysing specific samples, a graphical user interface (GUI) was developed to visualize and analyse the resulting images more efficiently.

THE RESULTS AND EXPECTED IMPACT

Each image depicts 90x90 µm concentrations maps of iron, zinc, calcium and phosphorous at two time points of the fibrosis development. Interestingly, both images show increased accumulation of iron, zinc and calcium within specific cell arrangements in the fibrotic lung tissue. We believe these scans has paved a way into an increased attraction of companies to synchrotron facilities to study the complex pathology of chronic diseases. Next, the partners will involve the correlation of imaging modalities (nano-XRF and multiplex immunofluorescence) to understand the results from all concentration maps of elements. Additionally, MAX IV plans to offer a “bundle package” for companies to assess metals in tissue samples.

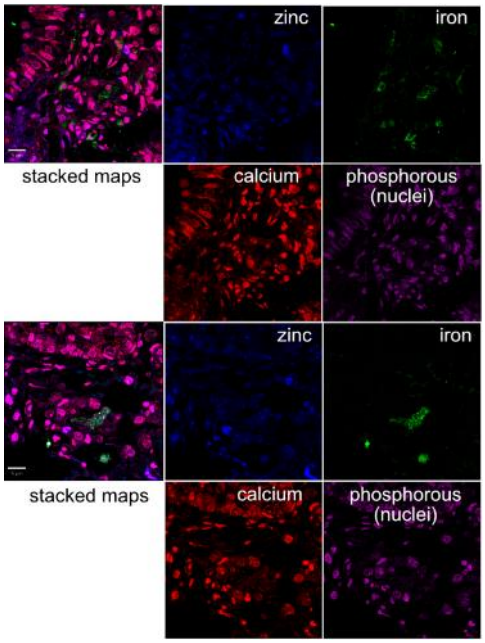


Figure. Concentration maps of fibrotic rodent lung tissue at two time points of the fibrosis development. Scale is 5 µm with 90x90 µm size of scale.

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