Cryogenic Analysis of Frozen Hydrated Biological Tissue at the Hard X-ray Micro-Probe Beamline at PETRA III

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Introduction and Objectives

A robust cryogenic workflow was developed at beamline P06 to minimise structural and chemical artefacts during sample preparation as well as beam damage during analysis. Shock frozen hydrated biological and medical tissue samples up to a diameter of 2 mm can be analysed. The developed instrument consists of a vacuum chamber (ca. 10^{-8} mbar), two cooling systems, one for rapid cooling at startup and one vibration free long term cooling system maintining the temperature between -120 °C and -150 °C, an ultrathin polymer window XRF detector, an absorption imaging detector (PCO 4000), and a cryogenic vacuum transfer system.
The presented system allows besides 2D and 3D elemental imaging also absorption and phase contrast tomography on the (sub-)micrometer scale.

Results and Discussion

Recent results will be presented, demonstrating the capabilities regarding absorption/phase tomography and fluorescence imaging on frozen-hydrated biological samples. Analysis of a rice leaf shows the ability of the presented instrument to obtain high resolution 3D images, while the Si elemental image shows the high sensitivity and resolution of the XRF imaging system.

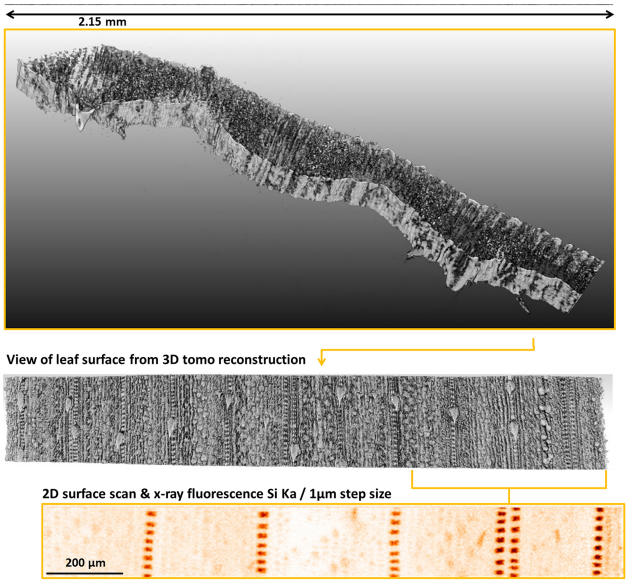

Figure 1 (Top) A crop of a 3D CT of a shock frozen hydrated rice leaf. (Center) Front absorption view (Bottom) A 2D XRF Si image, showing Si inclusions in the epidermis of a rice leaf.

Conclusions

Combining a full cryogenic workflow with a cryogenic measurement instrument allows for high resolution structural and high sensitivity elemental analysis without the need of any chemical sample preparation steps, preserving the original state as much as possible.