EUROPEAN SYNCHROTRON RADIATION FACILITY

INSTALLATION EUROPEENNE DE RAYONNEMENT SYNCHROTRON

Experiment Report Form

The double page inside this form is to be filled in by all users or groups of users who have had access to beam time for measurements at the ESRF.

Once completed, the report should be submitted electronically to the User Office using the **Electronic Report Submission Application:**

http://193.49.43.2:8080/smis/servlet/UserUtils?start

Reports supporting requests for additional beam time

Reports can now be submitted independently of new proposals – it is necessary simply to indicate the number of the report(s) supporting a new proposal on the proposal form.

The Review Committees reserve the right to reject new proposals from groups who have not reported on the use of beam time allocated previously.

Reports on experiments relating to long term projects

Proposers awarded beam time for a long term project are required to submit an interim report at the end of each year, irrespective of the number of shifts of beam time they have used.

Published papers

All users must give proper credit to ESRF staff members and proper mention to ESRF facilities which were essential for the results described in any ensuing publication. Further, they are obliged to send to the Joint ESRF/ ILL library the complete reference and the abstract of all papers appearing in print, and resulting from the use of the ESRF.

Should you wish to make more general comments on the experiment, please note them on the User Evaluation Form, and send both the Report and the Evaluation Form to the User Office.

Deadlines for submission of Experimental Reports

- 1st March for experiments carried out up until June of the previous year;
- 1st September for experiments carried out up until January of the same year.

Instructions for preparing your Report

- fill in a separate form for each project or series of measurements.
- type your report, in English.
- include the reference number of the proposal to which the report refers.
- make sure that the text, tables and figures fit into the space available.
- if your work is published or is in press, you may prefer to paste in the abstract, and add full reference details. If the abstract is in a language other than English, please include an English translation.

ESRF	**Experiment title:** Three-dimensional Quantitative Investigation of Fruit Tissue Microstructure in a Multi-scale Modelling Framework	**Experiment number**: Ma222
Beamline: ID19	**Date of experiment**: from: 4/11 to: 7/11	**Date of report**: 29/08/07
Shifts: 9	**Local contact(s)**: Peter Cloetens	*Received at ESRF:*

Names and affiliations of applicants (* indicates experimentalists):

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Report:

The cellular metabolism of plant organs is the basis for cell maintenance, growth, reproduction and adaptation. Metabolic processes require the supply of chemical compounds to and from cells. Our understanding of the exchange mechanisms critically depends on insights in the structural arrangement of cells and tissues in plant organs. Here we show for the first time using synchrotron X-ray computed tomography how pome fruit tissues are spatially organized to facilitate or impede gas exchange (Figure 1). We visualize 3D networks of gas-filled intercellular spaces in apple and pear fruit that provide the main routes for exchange of oxygen and carbon dioxide with the environment. The differences in void dimensions and connectivity between tissues and fruits help explain imbalances in gas exchange that may result in internal disorders and structural degradation. In terms of facilitating gas exchange, the ingenious network pattern of the voids in pears is by far not effective to compensate for the large size and volume fraction difference with the unconnected void structure we find in apple. The partial breakdown of such networks would quickly lead to an internal gas imbalance. We also show for the first time that tomography with synchrotron radiation, operated in phase-contrast mode, is able to visualize the 3D geometry of individual cells of biological tissues with high water content with submicron voxel resolution. The achievement of high-resolution 3D microstructural properties of cells and tissues is an important breakthrough for the study of exchange mechanisms in plant materials. In addition to gas exchange, the results will benefit the study of water relations and mechanics of plants.

References

Pieter Verboven, Greet Kerckhofs, Hibru Mebatsion, Fernando Mendoza, Kristiaan Temst, Martine Wevers, Peter Cloetens, Bart Nicolaï. 2007. Comparison of different X-ray computed tomography techniques for the quantitative characterization of the 3D microstructure of pear fruit tissue. *Proceedings of the 4^th^ International Conference on Emerging Technologies in NDT*, Stuttgart, Germany, April 2-4. 6 pages.

Pieter Verboven, Greet Kerckhofs, Hibru Kelemu Mebatsion, Kristiaan Temst, Martine Wevers, Peter Cloetens, Bart M. Nicolaï. 2007. Gas exchange mechanisms in pome fruit characterised by synchrotron X-ray computed tomography. *Nature*, submitted.

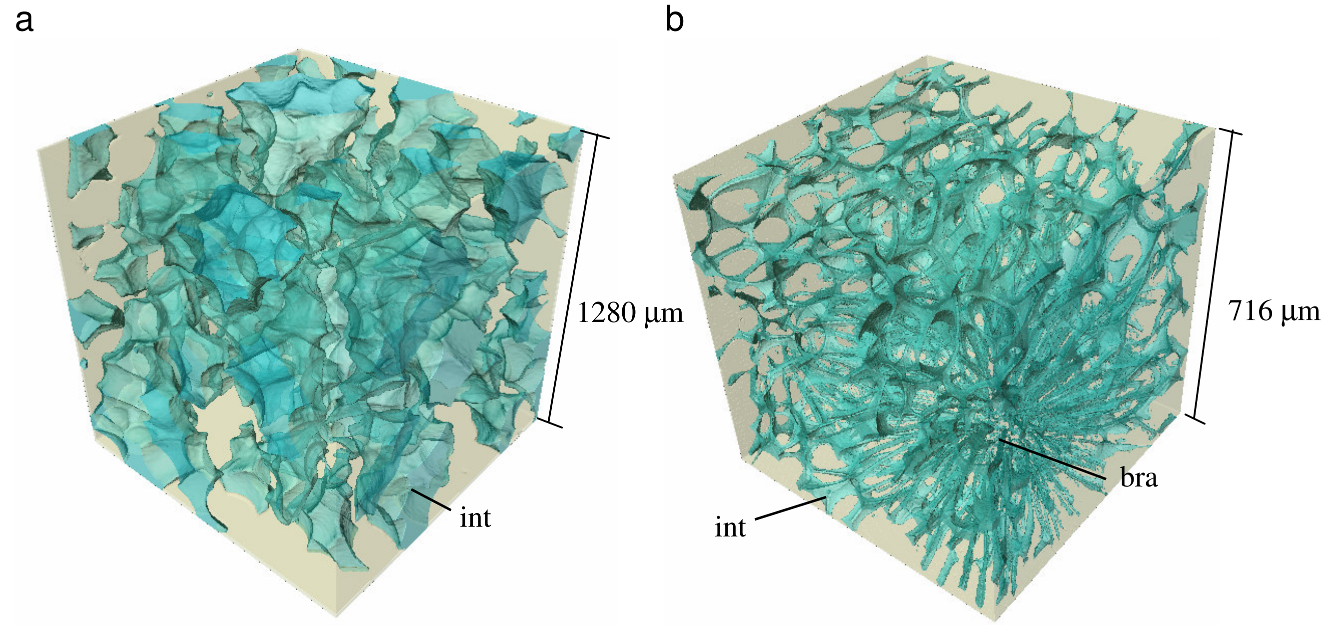

Figure 1. 3D rendering of the void network of apple (a) and pear (b) fruit cortex. The marked components are the intercellular void spaces (int) and the brachysclereids (bra). While the voids between apple parenchyma are large and form an incompletely connected network, those of pear are very small and form a complete network throughout the cortex sample without preferential direction.