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Bâtiment 522 - Salle 138

«Synchrotron Facilities And Multi-scale Structure Of Biopolymers Assemblies»

Synchrotron techniques are being increasingly used on plant biopolymers and plant assemblies for a better understanding of biosynthesis, multi-scale structure or fractionation (biorefinery). This knowledge is essential to achieve a better use of agricultural resources for essential applications such as healthy food engineering, bio-based materials design, biofuels production and environmental remediation. The presentation briefly describes some results obtained at SOLEIL and ESRF on starch and to a lesser extent on plant cell walls polysaccharides. Starch is the major energy reserve of a large variety of higher plants. It is the predominant carbohydrate in our food. It is also being increasingly used in many non-food issues like pulp and paper industry, pharmaceutical applications, adhesives, materials, biofuels etc. Starch has a complex granular structure exhibiting size and shape dependence on botanical origin. This granule has been shown to be made of stacks of amorphous and semi-crystalline growth rings (120-400 nm thick). The semi-crystalline shells are composed of alternating crystalline and amorphous lamellae repeating in 9-10 nm. Most uses of starch require the disruption of the starch granules through enzymatic and/or hydrothermal treatments. On native single starch granules, synchrotron was used for mapping both the crystalline structure and orientation (microbeam diffraction)¹ and phosphorus or sulfur content (X-ray microfluorescence) at the micron scale. A new high resolution (0.13 nm) 3D model for starch crystal domains² has also been determined using microbeam diffraction on individual micron-sized single crystals. The other examples concern enzymatic and hydrothermal treatments of starch. Besides the evolution of both the lamellar (10 nm) and the crystalline structure (0.3 to 1.6 nm) during hydrothermal treatments (SWING beamline), the structural anisotropy present in shape memory starch-based materials was analyzed by SR polarized infrared micro-spectroscopy (SMIS beamline)³. Remarkable results were also obtained on enzymatic hydrolysis of concentrated native starch, taking advantage of new techniques implemented at SOLEIL. Synchrotron UV fluorescence was used for high resolution (280 nm) 3D mapping of hydrolytic enzyme (amylase) within single starch granules without staining,^{4,5} and synchrotron circular dichroism (SRCD) in turbid medium to approach the conformational changes of enzyme when adsorbed onto solid starch (DISCO beamline). The application of these different techniques to other plant biopolymers and their assemblies is also discussed.

References

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2. Popov, D. Buleon, A. Burghammer, M. Chanzy, H. Montesanti, N. Putaux, J. L. Potocki-Veronese, G. Riekkel, C. *Macromolecules* **42**, 1167-1174 (2009).
3. C. Véchambre, A. Buleon, L. Chaunier, F. Jamme, D. Lourdin *Macromolecules*, **43**, 9854-9858 (2010)
4. G. Tawil, A. Vikso-Nielsen, A. Rolland-Sabate, P. Colonna, A. Buleon, *Biomacromolecules*, **12**, 34-42 (2011)
5. G. Tawil, F. Jamme, M. Refregiers, A. Vikso-Nielsen, P. Colonna, A. Buleon "In situ tracking of enzymatic breakdown of starch granules by synchrotron UV fluorescence microscopy" *Anal. Chem.*, **83**, 989-993 (2011)

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