INDUSTRIAL DEVLOPMENT PROJECTS

Real time Neutron and X-ray Imaging to characterize water transport mechanisms in sustainable paper straws

THE INDUSTRIAL CHALLENGE

Deeper knowledge and novel methods about time resolved water transport processes and interactions through paper fibre networks is needed. This information is useful in the packaging industry during material research in the development process of new sustainable paper products, such as paper-based barriers.

WHY USING A LARGE-SCALE FACILITY

The enhanced contrast mechanism to find and trace water i.e. hydrogen that neutron techniques provide, in comparison to X-ray methods, makes it possible to resolve subtle changes of the water/liquid in the fibre network. Time-resolved X-ray Computed Tomography (XCT) complements with structural information of fibers in 3D/4D with high spatial resolution at rapid acquisition rates. This can in turn be used to follow water interactions indirectly through swelling of the fibre network

HOW THE WORK WAS DONE

Two different time-resolved *in situ* 2D-neutron radiography experiments of the liquid imbibition process in paper fibre materials were performed. The ICON instrument at SINQ at the Paul Scherrer Institute (PSI) in Switzerland was used together with the instrument scientist Dr. Anders Kaestner. Thin (150 µm), rectangular shaped paper strips were submerged into different liquids on one of the edges and the water movement were monitored. 2D-neutron radiographies were continuously acquired during the water migration process into the cellulose network samples. Secondly, the NeXT instrument at Institut Laue-Langevin (ILL) in France was used, with a sample environment and experimental setup optimized to be able to acquire 3D-images as well. The instrument scientist, Dr. Alessandro Tengattini introduced the instrument and helped us setting up the experiments. Moreover, thanks to the high neutron flux, and the X-ray source, available at NeXT, we collected dual modality (neutron and X-ray) 3D-images before and after the wetting process. Sample environments with flexibility to cater different sample sizes and shapes were discussed and developed during the project together with the instrument scientists at the neutron facilities and designed/ manufactured by Lund University.

THE RESULTS AND EXPECTED IMPACT

The novel data acquired, will be used to identify material properties and to calibrate material parameters to be used in the virtual simulation models at Tetra Pak®. We have quantified the time resolved liquid movements in paper strips of cellulose fibre materials and finally measured on the developed and manufactured end product of paper straw tests presented in Figure 1.

During the course of the work, Tetra Pak® has learned a lot about neutron tomography and the opportunities of this method. We are now better prepared to perform experiments at the ODIN Imaging instrument and to engage much more easily with the staff and instrument scientists at the upcoming neutron facility ESS in Lund, Sweden. The terminology and the mindset when performing neutron experiments are also becoming much clearer for us in the industry presently.

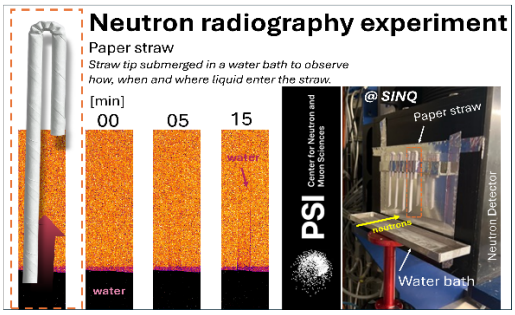

Figure 1. Time resolved 2D neutron radiographies showing water uptake in the paper straw (left), and the experimental setup with one of the sample environments used at the ICON instrument (right)

"Neutron research has huge potential in uncovering important new findings, and the industry will benefit greatly from ESS and the opportunities that the facility provides."/Joakim Tuvesson – Vice President Materials and Package, Tetra Pak

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