INDUSTRIAL DEVLOPMENT PROJECTS

# Synchrotron 4D-microtomography for imaging of microstructural evolution and liquid transport in sustainable paper straws

## THE INDUSTRIAL CHALLENGE

Tetra Pak® aims to increase the renewable content in carton beverage packages to 100%. The mechanical performance of wood fibre based cellulose materials is influenced by moisture and water. Therefore it´s critical to predict and optimise dynamics and transport mechanisms involved during manufacturing and consumer usage. These phenomena are in turn a great challenge to study at high resolution in real conditions.

## WHY USING A LARGE SCALE FACILITY

Laboratory CT-equipment suffers with scan times that commonly is in the order of hours to be able to obtain high resolution. On the contrary, the high flux X-ray beam at a synchrotron facility allows rapid time resolved X-ray microtomography (4D-Imaging) studies due to acquisition times in the order of seconds or minutes.

## HOW THE WORK WAS DONE

Two synchrotron 4D-imaging experiments of the evolution of the paper fiber network material structures were performed, using a novel experimental setup for mimicking the intended liquid imbibition conditions designed, developed and manufactured within this project (Figure 1).

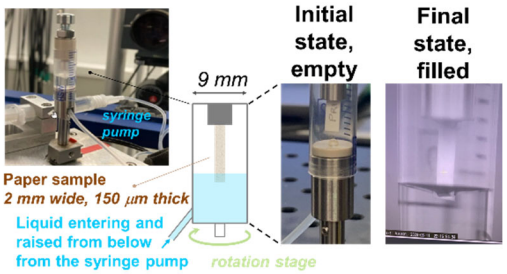


**Figure 1**. The novel sample environment

The first was performed at the TOMCAT beamline X02DA at the Swiss Light Source, Paul Scherrer Institute (PSI), Switzerland where the high-speed capabilities were used to study the absorption process in real-time. Exploratory measurements with higher spatial resolution were later performed at the ForMAX beamline at the MAX IV Laboratory, Sweden. We initially imaged the dry sample and then continuously CT-scanned during the liquid absorption process to acquire 4D information of the microstructure evolution. Our beamline contacts at TOMCAT (Christian Schlepütz) and ForMAX (Samuel McDonald) and beamline staff are thanked for all their dedication, help and hard work.

## THE RESULTS AND EXPECTED IMPACT

By utilizing the novel sample environment, we acquired high-resolution 3D images during the wetting process (Figure 2). With this high-quality data, we gained new insights about how different liquids interact and influence the paper fiber network structures in 4D. This increased understanding of the dynamics and transport mechanisms was used to extract quantitative information (pore size, fiber network etc.) and to calibrate material parameters. This will improve our simulation models significantly. With these improved tools and new insights, Tetra Pak® is now better equipped to take on the quest to improve the functionality of paper straws.

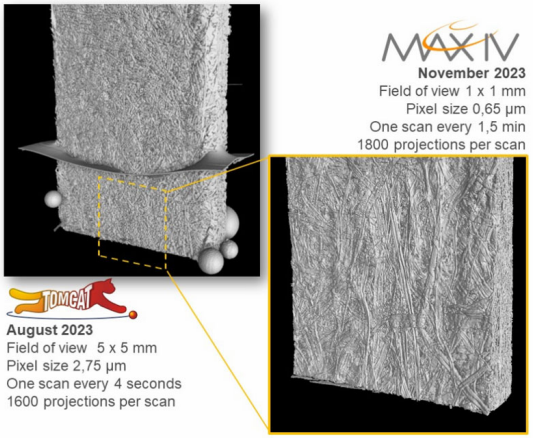


**Figure 2**. 3D reconstructed data from TOMCAT (left) and ForMAX (right) of the paper fiber network

***Our ambition is to provide the world's most sustainable food package, and experiments at ForMAX will support us in this mission."*** ***/Eva Gustavsson, Vice President, Materials & Package at Tetra Pak®***

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