INDUSTRIAL PILOT PROJECT

Novel investigation of the water transport in porous cellulose fibre networks using neutron imaging

THE INDUSTRIAL CHALLENGE

It is well known that the uptake of water affects the mechanical properties and the dimensional stability of cellulose fibre network materials. Due to this impact, products that are expected to be in contact with water undergoes sizing which is a chemical treatment that causes the fibre surfaces to become hydrophobic. While the effect of the chemical sizing process is well documented, it is not understood in detail how water is transported in cellulose fibre networks. It is also not known how the transport mechanisms are affected by different sizing treatments, or by creasing (which is a mechanical process to locally damage the material before folding).

WHY USING A LARGE SCALE FACILITY

The water distribution in materials can be measured using neutron imaging. While x-ray imaging, even from a laboratory source, can provide higher spatial resolution, neutron imaging provides better contrast between the cellulose and the water. To be able to follow the transport of water in the material, the high neutron flux only provided by large scale facilities is necessary.

HOW THE WORK WAS DONE

The evolving water distribution in cellulose based paperboard was probed with neutron imaging during in-situ edge wetting at the D50 beamline at the Institut Laue-Langevin (ILL) in Grenoble. Measurements were made on samples with different degree of sizing as well as on samples that had also undergone creasing The measurements were performed by representatives from BillerudKorsnäs, with support from staff from Lund University. Furthermore, the beamline scientists L. Helfen and A. Tengattini at the D50 beamline were involved in the design and execution of the experiment.

In preparation for the neutron measurements, a specially designed wetting device through which water was injected into the samples was constructed and tested. Due to the hydrophobicity of the sized paperboard, increased water pressure was needed for this depending on the degree of sizing.

THE RESULTS AND EXPECTED IMPACT

The measured data clearly showed how the sizing treatment hinders the water penetration and reduces the water propagation rate in the material. It is also clearly shown how the presence of a line crease significantly increases the water propagation rate locally close to the crease, see Figure.

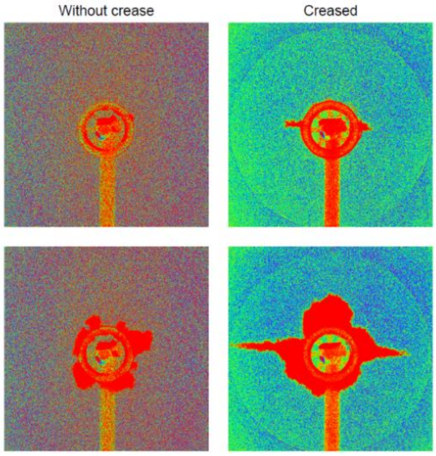

Figure. Neutron imaging data showing the evolving water distribution for a sample without crease (left) and a sample with a horisontally oriented line crease (right). The water is clearly seen as the red area propagating out from the centre. Each pair of images (left-right) were acquired after the same duration from the beginning of each measurement.

Alongside delivering novel experimental results that will be used in the ongoing development of physically-based models of the water transport in paperboard, this pilot study has shown that neutron imaging displays great potential to be used further.

"Neutron imaging is a powerful tool for better understanding of water transport in cellulose fibre networks."
/Gilbert Carlsson, BillerudKorsnäs

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Vinnova's project No: 2018-04414 **Duration:** November 2018 – November 2019

Funded by Sweden's Innovation Agency, Vinnova, in order to build competence and capacity regarding industrial utilisation of large-scale research infrastructures such as MAX IV and ESS.