INDUSTRIAL PILOT PROJECT

Renewable packaging materials-impregnation depth measurements for pulping industry using synchrotron XRF

THE INDUSTRIAL CHALLENGE

The environmental impact of plastic packaging is a growing concern but using wood fibre-based materials as a replacement could significantly reduce the problem. High Yield Pulps (HYP), such as Chemithermomechanical pulp (CTMP) will be a major component of sustainable packaging materials in future. The major challenge for CTMP is to achieve the even distribution of sulphite (SO_3^{2-}) ions in the inner-and outer parts of the wood chips to preserve in homogenous wood fibre properties. However, the sulphonation degree and softening of each fibre in the chip refiner before being defibrated is largely unknown at a micro-scale level. There is currently no easy method to measure the distribution of sulphonate groups either in wood chips or the individual fibres.

WHY USING A LARGE SCALE FACILITY

Synchrotron XRF imaging technology is a suitable way to achieve high resolution imaging measurements of sulphur distribution between fibres and also within individual fibres, since the image resolution achieved is 1 µm.

HOW THE WORK WAS DONE

Thin paper sheets with diluted sulphonated fibre content were required for investigation at the synchrotron. Since kraft pulp is sulphur free due to thoroughly wash, Valmet pilot CTMP pulp sample diluted with different percentages of SCA kraft pulp assured individual sulphonated fibre observation in 20 g/m^2 paper sheets that were produced.

Two beamtime applications were approved from two synchrotrons:

1. The Phoenix beamline of the Swiss Light Source (SLS) in Switzerland.
2. The 2-ID-D beamline of the Advanced Photon Source (APS) in USA.

The samples were measured by remote access due to pandemic restrictions, but in live contact with beamline scientists Camelia Nicoleta Borca at SLS/PSI and Barry Lai at APS.

THE RESULTS AND EXPECTED IMPACT

PSI measured in vacuum, which enabled to see a both sodium (Na) and sulphur (S), Figure 1. Sulphur shows good accuracy and is used further in the project.

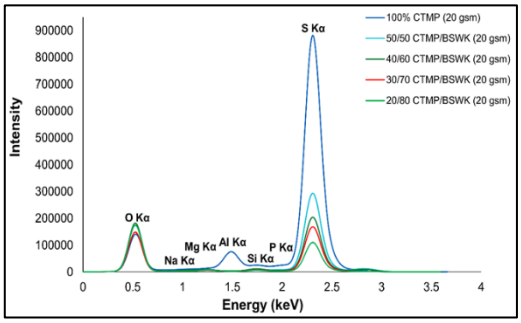

Figure1. Sample spectra from PSI using 0.5 × 0.8 mm spot size for area averaging.

APS focused on imaging with 1 µm spatial resolution in air. Figure 2 clearly reveals significant variation in sulphonation.

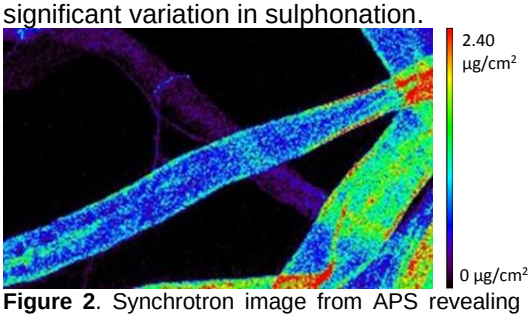

Figure 2. Synchrotron image from APS revealing uneven sulphur homogeneity on individual fibre level in CTMP pulp

The conclusion of this project is:

1. The sulphur content of fibres in the sample varies. Within fibres, the sulphonation seems uneven, with higher concentration at the fibre surface.
2. The resolution needed for homogeneity measurements must be able to resolve sulphur within individual fibres.
3. Such measurements can assist in optimizing process parameters to reach even impregnation for the manufacture of advanced fibre materials.

The final goal is increased pulp yield with lower shives providing energy saving and minimizing sulphite doses.

BILLERUDKORSNÄS

Valmet FORWARD

Mittuniversitetet MID SWEDEN UNIVERSITY

Contacts: Henrik Edlund – BillerudKorsnäs Frövi, henrik.edlund@billerudkorsnas.com
Fredrik Lundström – Valmet AB, fredrik.lundstrom@valmet.com
Börje Norlin – Mid Sweden University, borje.norlin@miun.se

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