INDUSTRIAL PILOT PROJECT

Mimicking the cleaning of pores using Ultra-pure water with small-angle X-ray scattering at MAX IV

THE INDUSTRIAL CHALLENGE

Every year billions of kg of detergents and cleaning agents are produced and used globally. Unfortunately, a large part ends up in the aquatic system and accumulates in living organisms. The Ultra-Pure DIRO-water produced by SWATAB has been shown to have the ability to clean without the need for detergents, even at room temperature[1]. The mechanism of how different types of water can lift and transport particles is not fully understood but crucial to optimize the process of cleaning without chemicals.

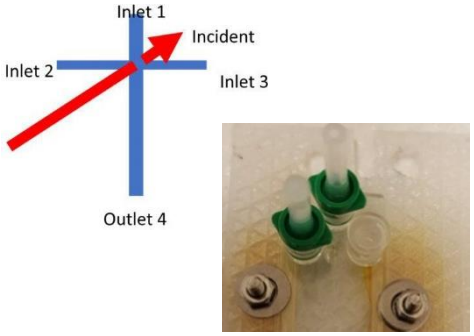
WHY USING A LARGE SCALE FACILITY

Lab-based methods have shown that particles and oil are dispersed readily in DIRO-water but were unable to show the release of particles from pores[2]. In order to mimic the process by which water can release dirt particles from pores or surfaces, a small-angle X-ray scattering experiment was designed to track the dispersion by water of nanoparticles from a pore. The CoSAXS technique allows quantifying the size and distribution of nanoparticles within a scattering volume.

HOW THE WORK WAS DONE

A small-angle X-ray experiment was carried out at the CoSAXS beamline of the MAX IV synchrotron by SWATAB and JOIN in strong collaboration with the beamline personnel at MAX IV laboratory and Malmö University.

A thermoplastic (COC) microfluidic chip (ChipShop) with a crossed slot design was installed within a 3D printedplastic holder on the motorized sample stage at the sample position. The channel width and depth were 200 x 200 nm. The microfluidic chip was positioned such that the X-ray beam was incident at the center of the cross (see illustration). The particle diameter was 22nm.



RESULTS AND EXPECTED IMPACT

The experiment allowed us to, for the first time, be able to see whathappens in real-time when DIRO-water comes in contact with “dirt,” lifts it, and removes it. We were also able to compare it with other types of pure water as well as a salt solution to mimic tap water. DIRO-water was able to extract the nanoparticles from the pore in a continuous manner, whereas de-ionized (Milli-Q) water showed a variation in the extraction rate. The DIRO-water caused no degradation to the nanoparticles as the size of the nanoparticles did not change. The results show that DIRO-water can indeed enhance the dispersion of nanoparticles from a pore compared to de-ionized water (Milli-Q) or tap water.

This experiment has already led to more research, and these results will be presented in articles during the summer.
The investigation highlighted the point that different methods to produce pure water are not equivalent. This may reduce or eliminate the need for detergents and surfactants generating a positive impact for both nature and mankind.

“This project shows the importance of collaboration between state-of-the-art synchrotron-techniques, science and the industry” / Mats Marklund, SWATAB

[1]https://bit.ly/32kLFs2
[2]https://doi.org/10.1016/j.jcis.2021.10.040

Contacts: Ann Terry – MAX IV (CoSAXS beamline), ann.terry@maxiv.lu.se
Per Hansson – Scandinavian Water Technology AB, per@swatab.com

Vinnova’s project No: 2019-05275 **Duration:** February 2020 -- March 2021

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.