Case study

QSense for analyzing the cleaning of hard surfaces using model and standardized stains

Introduction

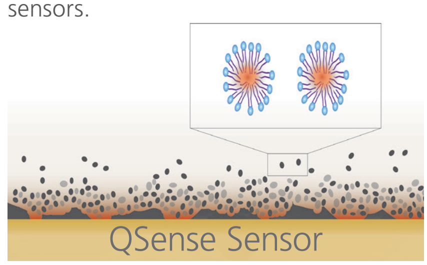
QSense can be used to analyze the cleaning efficiency of detergent formulations in real-time. Parameters that can be obtained from such studies include real-time removal rates, structural changes of the stain and final overall efficiency of the formulations analyzed.

In this case study QCM-D is used to study the efficiency of different detergent formulations on two different fat stains: a fat model stain consisting of a single lipid molecule (triolein) and an industry standard used cooking fat obtained from the Center For Testmaterials BV.

Experimental

In the first study, a single lipid (triolein) was spin-coated onto a gold QSense sensor to produce a model stain. The interaction and removal efficiency using the non-ionic surfactant TritonX was subsequently analyzed. Parameters such as surfactant concentration and different temperatures were also assayed in this first study.

In the second study, in order to achieve a more realistic stain than the single lipid model stain, standardized used cooking fat (SUCF) obtained from the Center for Testmaterials BV was spin-coated onto a silica QSense sensor (a mimic for glass surfaces). In comparison to the single lipid model stain previously used, this stain is a highly complex mixture of fat and proteins. To assay cleaning efficiency and stain behavior upon formulation addition, two commercial dishwashing powders at identical concentrations, detergent A and B, were injected over the coated sensors.



Experiments were carried out in flow mode, starting in MQ water, followed by sample solutions and subsequent MQ water rinse. Unless stated otherwise the measurements were performed at 25°C.

Results and discussion

Both triolein and SUCF were coated onto gold and silica QSense sensors respectively. The approximate thicknesses of the films were in the range of 30-40 nm. Since triolein is a liquid at room temperature, it was necessary to use these sensors immediately after preparing them. On the other hand, the SUCF had a significant shelf-life.

Removal of triolein at different concentrations and temperatures

At all concentrations, TritonX initially caused swelling of the triolein stain **(Fig. 1)**. A likely explanation for this is that the surfactant penetrates the stain and brings in coupled water causing a thickness increase **(Fig. 1)**.

At concentrations below the, CMC TritonX either adsorbed to (0.1 x CMC) or partially removed the stain (0.9 x CMC). However, at concentrations above the CMC (10 x CMC) almost all of the stain was removed **(Fig.1)**.

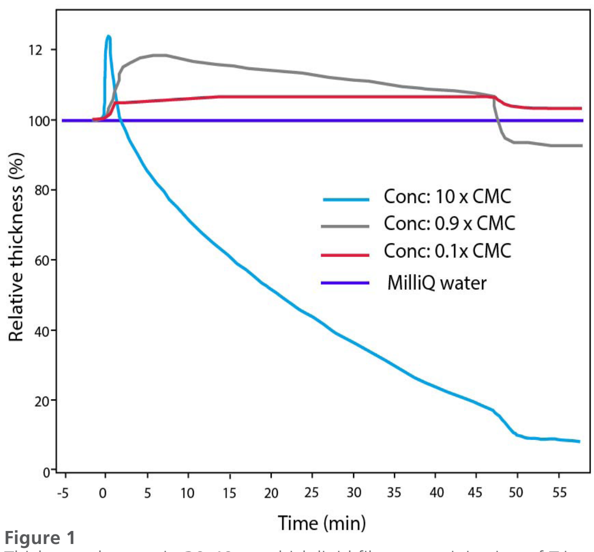


Figure 1
Thickness changes in 30-40 nm thick lipid films upon injection of TritonX-100 (0 min) and subsequent rinse with water (50 min) at 40 °C. TritonX-100 concentrations used were 0.1xCMC, 0.9xCMC and 10xCMC. MQ water was used as reference. 100% refers to the initial thickness of the triolein film.

In the first experiment the effect of temperature on removal rate was also investigated. As seen in **Fig.2** the soil removal is higher at 40 °C than at 25 °C.

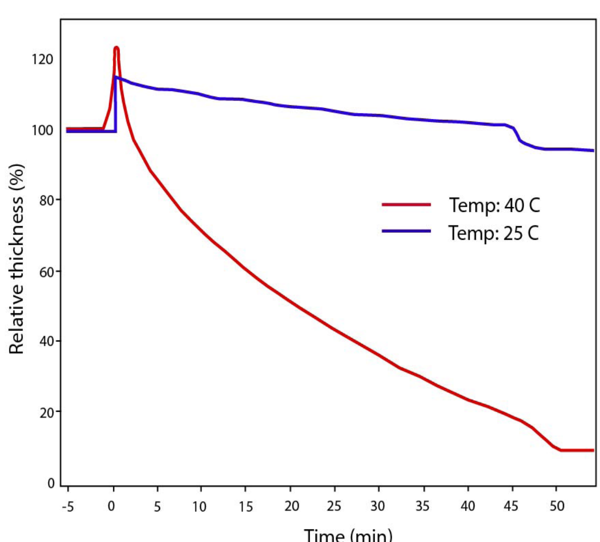


Figure 2
Thickness changes in 30-40 nm thick lipid films upon injection of TritonX-100 (0 min) and subsequent rinse with water (50 min) at 25 °C and 40 °C.

Removal of SUCF by two commercial detergents

Similar to the triolein-TritonX study, both commercial detergents bound to the stain and initially caused swelling, with detergent A causing significantly more swelling than did detergent B **(Fig.3)**.
The removal rates and cleaning efficiency of the two formulations were significantly different with detergent B partially removing the stain before rinsing whereas detergent A swelled before rinsing. **(Fig.3)**.

After rinse with MQ water, the removal rate of detergent A significantly increased leading to a greater removal overall than detergent B.

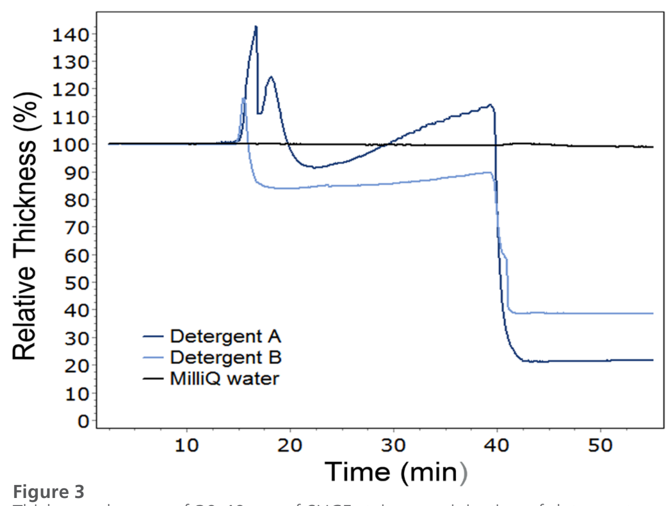


Figure 3
Thickness changes of 30-40 nm of SUCF stain upon injection of detergent A (dark blue) and B (light blue), and subsequent rinse with MQ water (38 min). MQ water reference is represented in black. 100% refers to the initial thickness of the stain film.

Conclusions

QSense can provide real-time information about adsorption of formulation solutions, cleaning efficiency and stain removal rates during the measurement.

The ability of coating complex and industry standardized stains onto the QSense sensor enables direct comparison between the data obtained at the nanoscale level with the more traditional test performed on the macroscale in for example dishwashing machines. The QSense measurements give valuable insights about the behavior of different detergents under different conditions.

References:

Measurements performed by Biolin Scientific /QSense Application Scientists.
Standardized fat provided by Center For Test Materials BV, the Netherlands.

Contact us at info@biolinscientific.com

Biolin Scientific
[Progress Together]