

Quartz Crystal Microbalance with Dissipation Monitoring
(QCM-D) Cleaning profile

FASTER.

CLEANER.

GREENER.

*Clever Characterisation for Smarter Formulation
Royal Society of Chemistry, Burlington House, Piccadilly, London*

Friday 10th November 2017
Dr Usha Devi
UK Territory Manager, Biolin Scientific

WHO WE ARE...

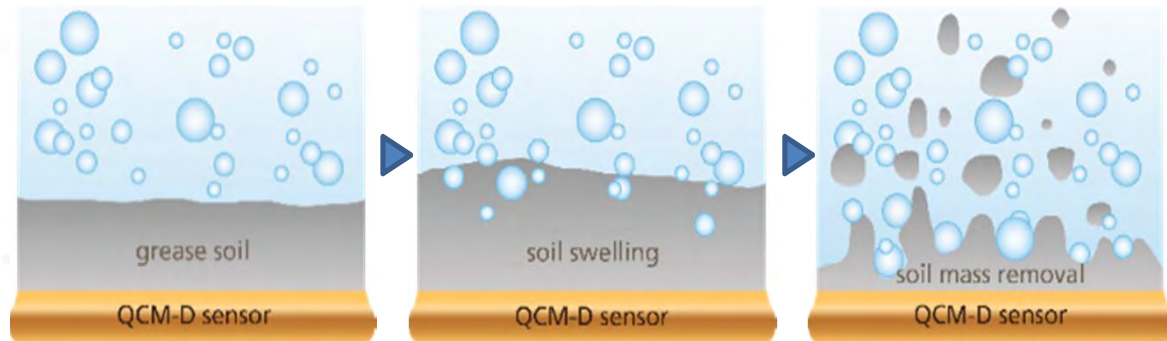
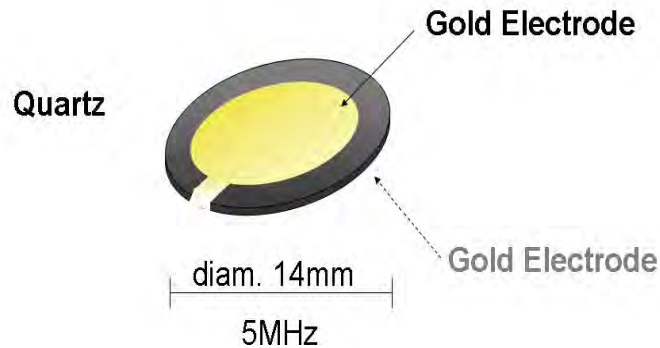
- >70 employees globally (~ 30% PhDs).
- Head office in **Gothenburg**, Sweden.
- R&D and manufacturing in Sweden and Finland.
- Direct sales in USA, UK and China, distributors in >70 countries
- Part of **Add Life**



MORE ABOUT WHO WE ARE...

- Surface science experts
- Widely adopted and accepted techniques and methods
- Thousands of publications
- Work with companies including Henkel, AkzoNobel, Clariant, BASF...

QSense QCM-D technology



- Sensor can be coated with a suitable soil for your experiment



Illustration of cleaning steps to obtain the cleaning profile.

- QSense enables analysis of molecular interactions and surface properties.

What are your main challenges for cleaning efficiency?

- Constant development of more efficient and eco-friendly detergents and formulations
- Slow R&D test methods

Basic, analogue techniques, e.g.

Visual inspection

Foam height (Ross Miles test)

Wettability (Draves method)

One point measures

Need to do several analysis methods/tests

Non-automated, manual methods



A fast lane to the future

QSense offers a method for efficient screening and ranking of surfactant / formulation candidates

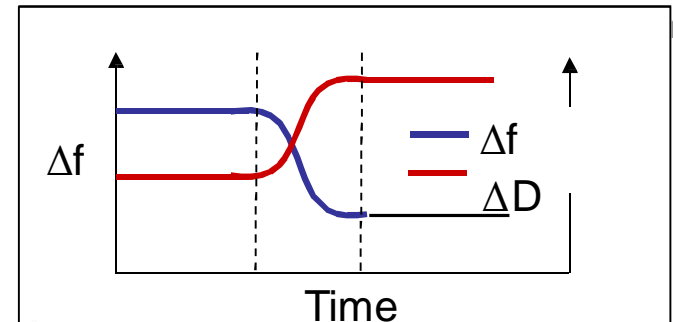
- Know **HOW FAST** your candidates clean.
- Know **HOW CLEAN** your candidates clean.
- Speed up the development of more efficient and **ENVIRONMENTALLY-FRIENDLY** products.

So that you can be **FASTER. CLEANER. GREENER.**



What makes QCM-D unique?

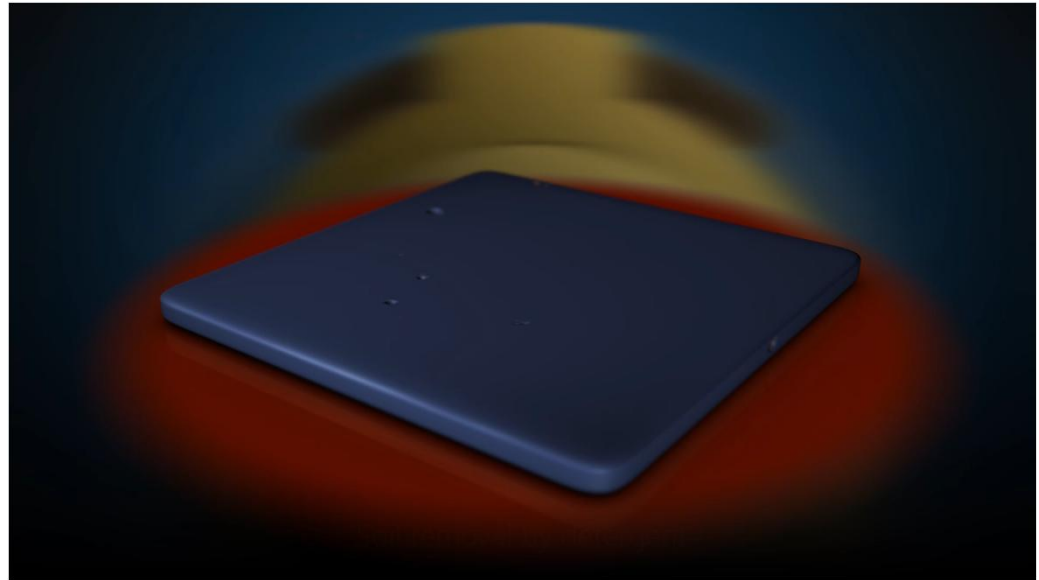
- Follow molecular events in REAL TIME
 - in liquid or in air
- Label free technique
- Measures frequency and dissipation changes
- ΔF a mass
 - Sauerbrey equation (uniform, rigid film)
 - Thickness
- Dissipation measurements – viscoelastic properties of the layer
 - How soft? How rigid?
- Measure mass 0.5 ng/cm² and thickness of molecular layers (resolution: 1Å - 1µM)
- Frequency range of 1-70MHz and time resolution of 200 data points per second
- Analyse structural properties of molecular layers, reproducible data
- Wide array of sensor coatings for specific applications
- *Understand how QCM-D is a valuable technique for your formulation research*



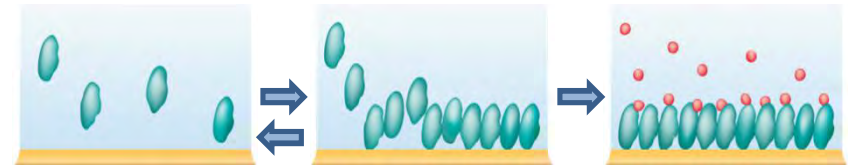
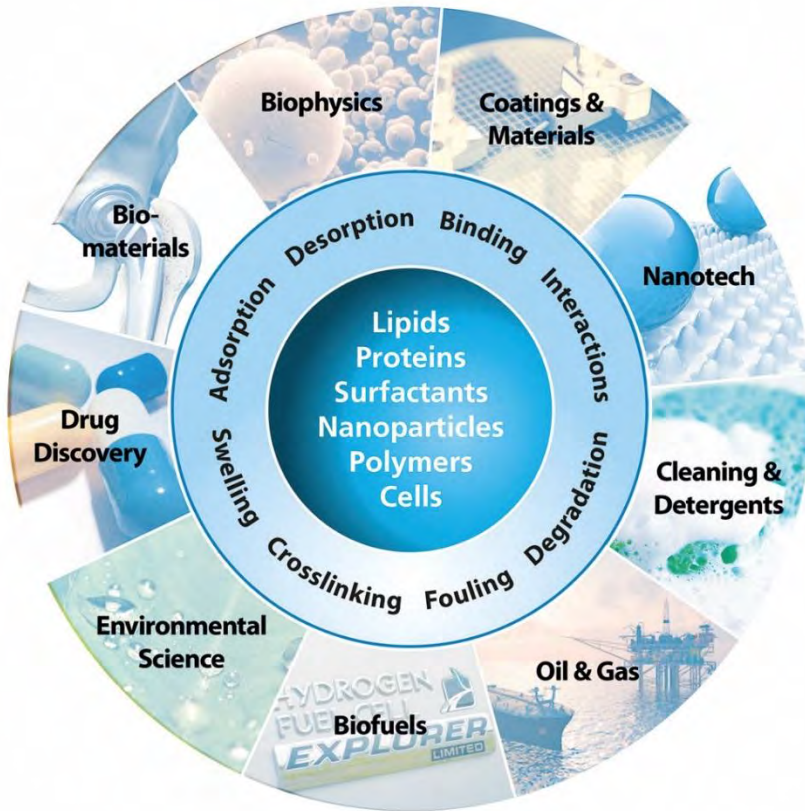
Soil removal is a chemical process



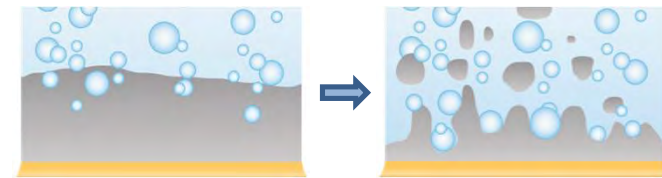
Sinner's circle



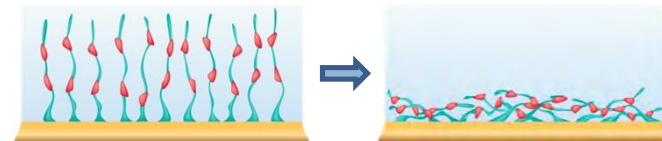
Application Areas



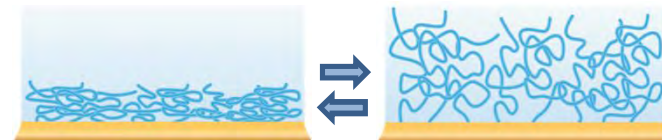
Absorption/Desorption/binding



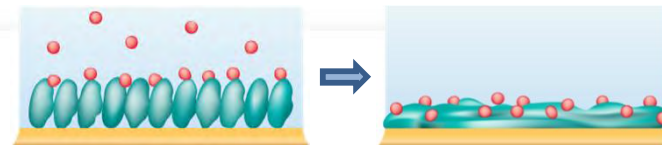
Degradation



Cross-linking



Swelling/collapse

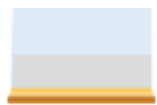
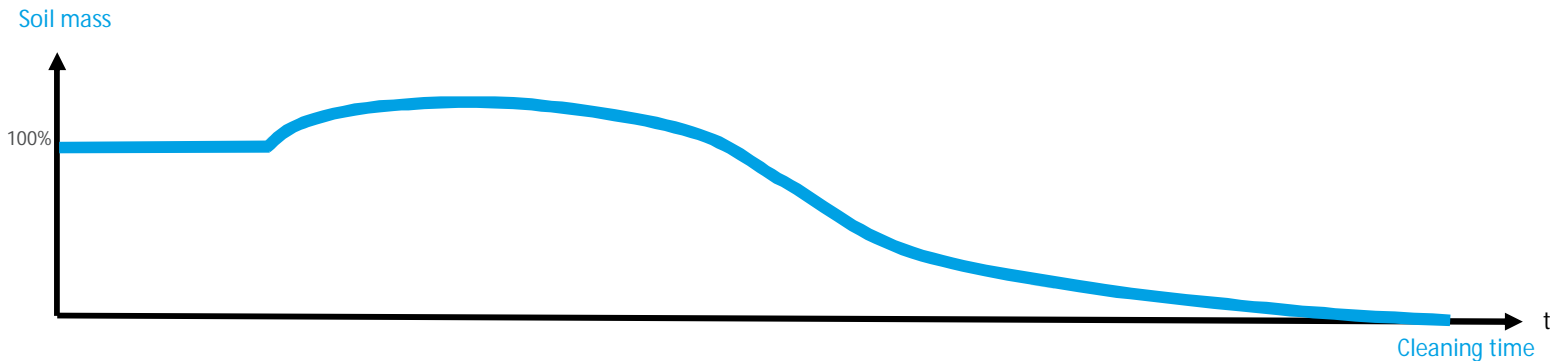


Conformational changes

The QSense cleaning profile

The chemical cleaning process in real-time

- How fast?
- How much soil is removed?
- Good or bad? Fast or slow?



Nano scale soil



Compound flow over sensor swells soil



Soil dissolves and leaves surface



Final cleaning result

Comparing different cleaning profiles



Cleaning profile A: SLOW

- 15% of the soil remains
- Cleaning process still ongoing
- Longer wash cycle required

Cleaning profile B: BAD

- 15% of the soil remains
- Cleaning process inactive
- Bad final result

Cleaning profile C: FAST

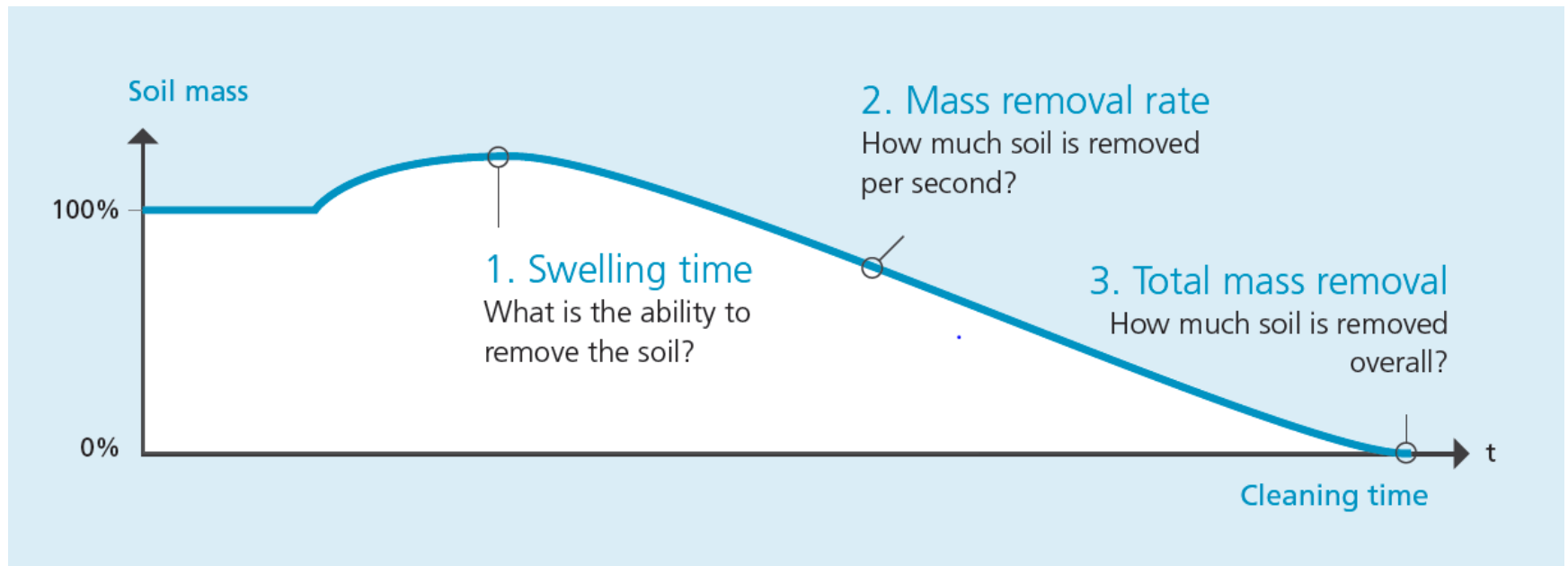
- 100% of the soil removed
- Cleaning process inactive
- Shorter wash cycle or less efficient candidate possible

Comparing candidates in varying conditions



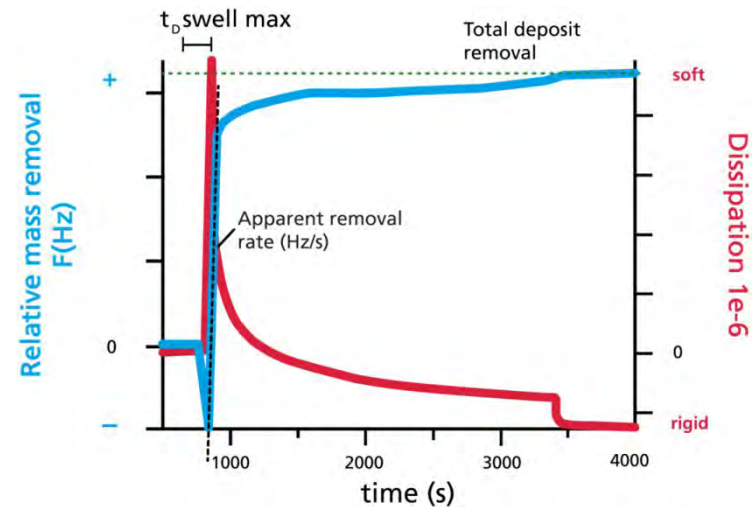
- Composition
- Concentration
- Temperature dependence
- Water quality
- Wash cycle time
- Pre-program and run up to 8 samples in one go
- Get high precision, real-time reproducible data

Three key values



Data derived from changes in frequency and dissipation

1. **Removal rate**
How much material is removed per second?
2. **Total removal**
How much soil is removed overall?
3. **t_D Swell Max**
How quickly does the soil swell?



Olesen, K, et al. Revealing detergent efficiency and mechanism by real-time measurement using a novel and tailored QCM-D methodology, *Tenside Surfactants*, 5, 2016

Evidence-based ranking of surfactants/formulations

Study by Biolin Scientific in collaboration with Center for Testmaterials BV(Netherlands)

- Swell time, mass removal rate and total mass removal tested for 9 commercially available formulations
- Rapid screening and ranking of the formulations was easily achieved
- Significant correlation found when comparing to Center for Testmaterials 'macro scale' set-up



<http://www.hanser-elibrary.com/doi/pdf/10.3139/113.110445>

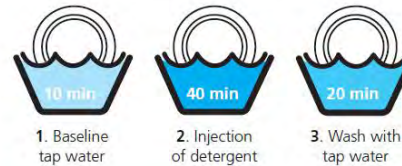
Evidence-based ranking of surfactants/formulations

1 Commercial detergents used in study



2 Wash cycle

Fixed concentration of detergents at 4 g/L and measured at 21°C. The cleaning cycle as outlined below was programmed into the QSoft Pro software.

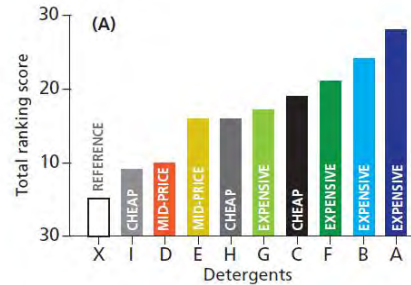


3 Sample data was collected

Data was collected as triplicates and run in a fully automated mode to maximize efficiency and reproducibility and analyze:

1. Swelling time
2. Mass removal rate
3. Total mass removal

4 Ranking result



AkzoNobel – an application example

In Q2 2017 AkzoNobel revealed new results for their ELFAN AT 84 G surfactant based on QSense Cleaning Profile

- Significantly better cleaning rate than competitor product
- Helps differentiate products
- Used both during and after the development phase
- QSense Cleaning Profile added to the ELFAN product data sheet

AkzoNobel Surface Chemistry

ELFAN® AT 84/ELFAN® AT 84 G
Mid anionic surfactant for cleansing systems

AkzoNobel

Easy to use, non-ethoxylated sulfite-free anionic surfactants ELFAN AT 84/ELFAN AT 84 G provide better cleansing and foam build-up than competitive benchmarks and similar cleaning performance to sulfated surfactants (SLS benchmarks). Based on vegetable fatty acid and readily biodegradable, it has superior clarity over other sulfite-free cleansers due to its highly efficient agglomerates and low residuals. Both grades are very effective even in hard water.

Effective gentle on skin with excellent dermatological profile. ELFAN AT 84 and ELFAN AT 84 G cleansing agents provide, clearly from its cleaning formulation, an extra step on skin needed to keep skin and soap coating healthy and conditioned.

Chemical structure of ELFAN AT 84/ELFAN AT 84 G:

CCCC(=O)OCCSO3Na

Key Benefits:

- ELFAN AT 84 and ELFAN AT 84 G cleansing agents allow formulators to create superior products compared to other Sodium Cocoyl Sulfonate alternatives.
- Mild surfactant that provides high foam build up and aqueous cleaning performance to related benchmarks (SLS).
- Excellent clarity, creamy and stable foams in soft and hard water.
- Excellent cleaner formulation that excels in both water and surfactant solutions. It covers all the residues due to its highly efficient surfactant, giving excellent care products superior clarity and foaming.
- Efficient cleaning with gentle on skin.
- Skin friendly, suitable use: **Transdermal Water Loss (TEWL)** compared to both Magnesium Lauryl Sulfate and Sodium Lauryl Sulfate.

Excelsant dermatological profile, non-irritating on skin, low impact on skin water.

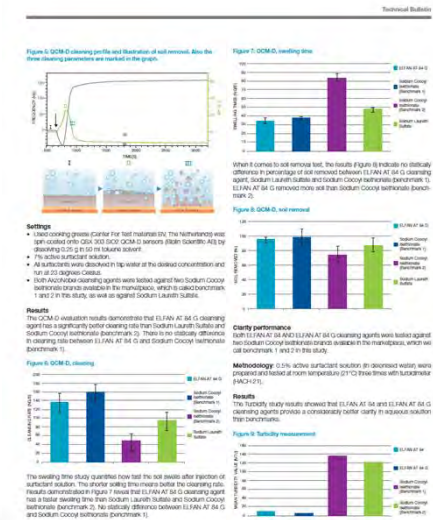
- Extra mild, safe for baby products and sensitive skin
- Ready biodegradable
- EO-free, sulfite-free anionic surfactant

Dimeric form (ELKOSOL AT 84 G)

- Non-toxic process for easy handling in manufacturing process.
- Suitable for soap bars giving excellent foam crests.

Suggested Applications:

1. Baby shampoo
2. Two-in-one shampoo/conditioner
3. Mousse, post-shower gels
4. Body wash
5. Facial wash
6. Liquid hand soap
7. Hygiene and control bar soap
8. Baby cleanser
9. Shaving cream



QSense Dfind analysis software

- A complete analysis toolbox in one intuitive software application
- Explore the full potential of your data
- Analyse all data in one go



QuickView and AutoPlotting to review and compare results



Material library and Model fit traffic lights



SmartTools analysis method toolbox



Batch mode and template tool



Report tool



Biolin Scientific

[Progress Together]

Contact UK

Usha Devi, Ph.D. UK

Territory Manager

Direct : 07738642463

