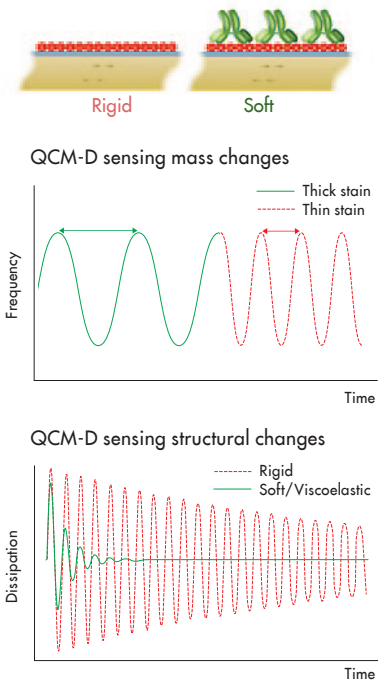
Q-Sense Pro

Real-time interface characterization

- Measure mass, thickness and structural properties of molecular layers
- Automated and fully integrated turn-key system
- 30 µl sample needed per sensor
- Real-time and label-free technology
- Flexible choice of surfaces
- 2x4 sensors for high efficiency
- Independent channels and automated mixing



Tracking changes at the surface

Q-Sense instruments are analytical tools for surface interaction studies at the nanoscale. On the QCM-D sensor they determine both mass and structural properties of molecular layers in real-time. This provides thorough understanding of e.g. molecular adsorption and orientation, layer thickness and softness/viscoelasticity, binding or no binding and more.

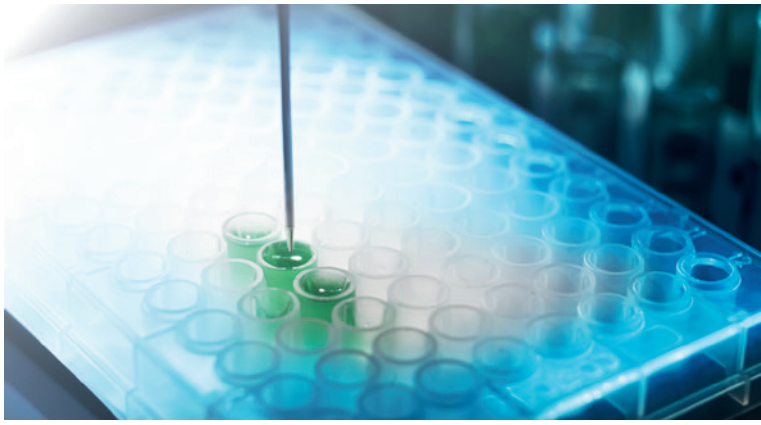
The Q-Sense Pro is based on the unique technology Quartz Crystal Microbalance with Dissipation monitoring, QCM-D. The instrument tracks changes in frequency and energy dissipation on a freely oscillating sensor. The resonance frequency of the sensor depends on the total mass, including water coupled to the oscillation. When molecules attach to the sensor, the frequency decreases. Sensing that frequency change, QCM-D operates as a sensitive balance, measuring mass and thickness of the adhering layer.

A soft film dampens the sensor's oscillation more than a rigid film. The damping or energy dissipation of the sensor's oscillation reveals the film's softness/viscoelasticity. In this way it is possible to extract valuable information about molecular binding to a surface, mass uptake or loss, layer thickness and softness/rigidity.

Q-Sense instruments are found in over 25 countries worldwide with users publishing and citing the use of the QCM-D technology

Processes QCM-D analyzes

- Adsorption
- Desorption
- Aggregation
- Binding
- Swelling
- Interactions
- Crosslinking
- Degradation

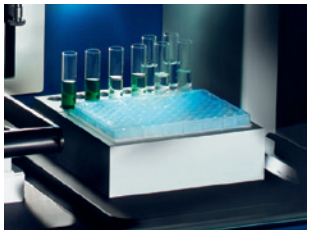


Q-Sense Pro

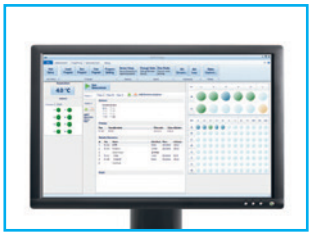
Real-time interface characterization

Use Q-Sense Pro in 4 simple steps:

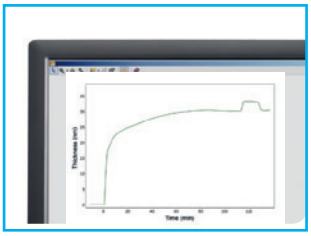
Mount up to 8 sensors of choice in the Pro Flow module and place the module inside the instrument chamber. Lower the handle to safely lock the module in position.



Place your sample vials in the thermo-blocks, fill the flask with solvent and make sure that the waste container and probe washing station are emptied from liquids.



Use QSoft Pro to program your desired sample sequence and press Start. The instrument will now run the experiment without any need for attendance or supervision.



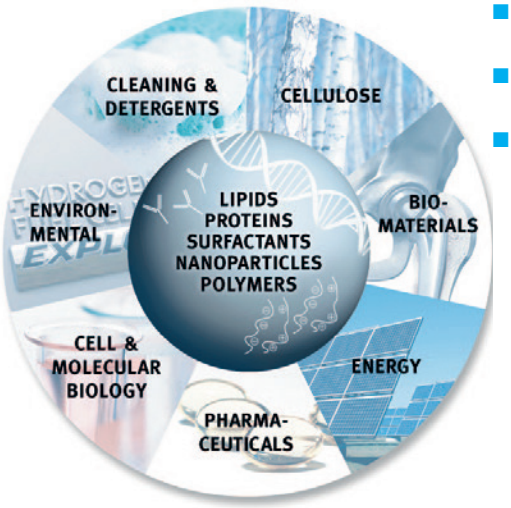
Use QTools software to analyze your data and acquire information about mass, thickness, softness/ viscoelastic properties, kinetic constants and adsorption phases.

Q-Sense Pro for your research

Quartz Crystal Microbalance with Dissipation monitoring, QCM-D, analyzes surface interactions at the nanoscale. QCM-D is a label-free and real-time technology, providing information about mass change as well as structural changes.

Q-Sense offers a wide range of sensors to be used in the Q-Sense Pro instrument. Whether you are interested in polymers, alloys, basic elements, functionalized surfaces or a number of other materials and molecules, QCM-D can be applied. Q-Sense Pro guarantees high reproducibility and flexibility. It is an automated system including intuitive software for set-up and analysis. Sample processing is easily prepared in the software where eight sensors can be programmed for measurement. They can run simultaneously in stagnant mode (8 sensors) or in series under flow (2x4 sensors). In flow, each channel runs independently with separate pumps.

Automated sample mixing and pre-programmed sample changes are features perfectly suited for set-ups that include multistep processes.



Q-Sense Pro is delivered fully equipped for use

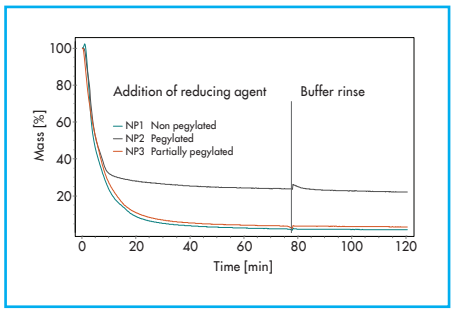
- Q-Sense Pro fow module
- Installation set and liquid handling set, including o-rings and tubings
- 10 sensors
- Thermoblocks of choice for your samples
- Software QSoft Pro and QTools
- 3 flasks (500 ml)

We invite you to discover Q-Sense Pro!

Q-Sense Pro

Real-time interface characterization

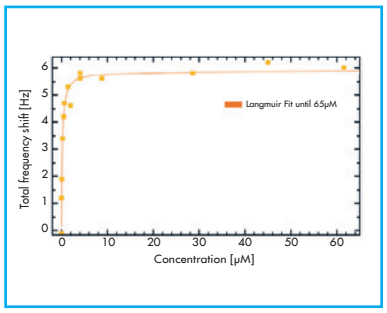
Nanoparticle research: Insulin-loaded nanoparticles interacting with lipid membranes



Analysis of nanoparticles (NPs) is a growing field of research in many application areas including nanomedicine, energy and nanocomposite materials. Here, three different NPs (NP1-NP3) were formed by mixing disulfide-linked polymers (SS-PAAs) with human insulin. QCM-D was used to study NPs interacting with and adsorbing to the model lipid membrane. The adsorbed NPs were subjected to conditions mimicking an intracellular reducing environment and QCM-D data clearly showed dissociation (mass decrease). From these experiments it was concluded that under cellular physiological conditions the NPs dissolved, likely resulting in insulin release.
Frost et al. J. Coll. Int. Sci. (2011), 362(2) 575-583

➜ **Only 30 µl sample required**

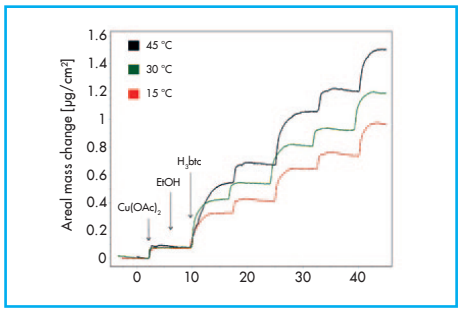
Energy: A study of dye-sensitized solar cells



Increased understanding of renewable energy sources is vital. One example is the dye-sensitized solar cell (Grätzel/Graetzel cell). Here, the adsorption of the dyes used in these solar cells was studied by QCM-D. The dyes were adsorbed onto flat TiO2 sensors and mesoporous TiO_2 sensors. The latter is a mimic for the materials used in the solar cell. Increasing concentrations of the dye Z907 was injected onto flat TiO_2, yielding increasing mass uptake. In the figure, the final change in frequency after injection and buffer rinse was plotted against dye concentration. From these data an equilibrium constant (Keq) for the adsorption of Z907 could be calculated.
Harms et al. PCCP (2012), 14(25):9037-40

➜ **Easy to program concentration gradients**

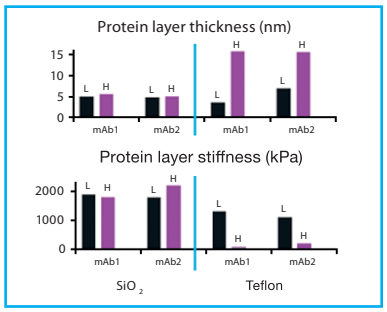
Build-up of layer-by-layer films: Monitoring of Metal-Organic framework assembly



QCM-D is often used to study build-up of layer-by-layer films (LbL). These films commonly consist of different polymers or polyelectrolytes. Here, step-by-step growth of the Metal-Organic framework (MOF) $Cu_3(btc)_2$ is monitored using QCM-D. The formation of $Cu_3(btc)_2$ on the sensor surface is achieved via alternating injections of $Cu(OAc)_2$ and H_3btc with an ethanol rinse in-between. The figure displays the increase in sensed mass during three such deposition cycles onto a SiO_2 sensor at the temperatures 15 °C, 30 °C and 45 °C. Reaction rates and thermodynamic parameters were successfully calculated from the QCM-D data.
Stavila et al. Chem. Sci. 3 (2012), 1531-1540

➜ **Program and press start – no supervision needed**

Protein pharmaceutics: Investigating protein aggregation pathways



Aggregation is a huge problem when working with protein pharmaceuticals. Adsorption of proteins to surfaces has the potential to partially unfold the protein which in turn can cause aggregation. Here, two antibodies at different concentrations (high, H, and low, L) were studied with QCM-D to investigate how formulation and external parameters affect surface adsorption. The figure shows the irreversibly adsorbed amount of protein to different surfaces (SiO_2 and Teflon). The concentration effect on adsorption is significantly higher on Teflon than SiO_2. mAb2 binds to a marginally greater extent on Teflon at the lower concentration than mAb1. The storage modulus of the adsorbed protein layer describes the stiffness of the layer (see figure). Thin layers of protein were stiffer than thicker layers of proteins, which are likely more hydrated.
Oom et al. J Pharm Sci. (2012), 101(2):519-29

➜ **Program several sequences in advance on up to 8 sensors**

Quality the easy way!

Q-Sense Pro

Real-time interface characterization

Sensors ans sample handling system	
Number of sensors	8 (up to 4 parallel measurements in flow mode)
Volume above each sensor	~ 5 µl
Minimum sample volume	~ 30 µl
Working temperature	4 to 70 °C, controlled via the software, stability ± 0.02 °C [A]
Typical flow rates	20-100 µl/min
Minimum dispense/aliquot volume	1 µl [B]
Sensors [C]	5 MHz, 14 mm diameter, polished, AT-cut, gold electrodes
Number of samples	Racks with up to 3 x 12 vials of Ø 13, 16 or 18 mm; or up to 3 x 24 of
	2.0 ml microtubes; or 1 x 96 microtiter plate + one of the above racks
Autosampler arm speed	350 mm/sec in X and Y dimensions, 125 mm/sec in Z dimension
Autosampler horisontal motion strength	X and Y: 2.0 kg (4.5 lb)
Autosampler vertical punch strength	3.2 kg (7 lb)

Frequency and dissipation characteristics	
Frequency range	1 – 70 MHz (allows 7 frequencies, up to the 13th overtone, 65 MHz for a 5 MHz sensor)
Maximum time resolution, 1 sensor, 1 frequency	~ 200 data points per second
Maximum mass sensitivity in liquid [D]	~ 0.5 ng/cm² (5 pg/mm²)
Normal mass sensitivity in liquid [E]	~ 1.8 ng/cm² (18 pg/mm²)
Maximum dissipation sensitivity in liquid [D]	~ 0.04 x 10^{-6}
Normal dissipation sensitivity in liquid [E]	~ 0.1 x 10^{-6}
Typical noise peak to peak (rms) in liquid [F]	~ 0.16 Hz (0.04 Hz)

Software	
PC requirements	USB 2.0, Windows 7, Vista or XP
Input data, analysis software	Multiple frequency and dissipation data
Output data, analysis software	Modeled values of viscosity, elasticity, thickness and kinetic constants
Import/export	Excel, BMP, JPG, WMF, GIF, PCX, PNG, TXT

Instrument dimensions			
Height [cm]	Width [cm]	Depth [cm]	Weight [kg]
70	67	57	83

Sense the difference Q-Sense Pro

Sample mixing and pumps working independently ensure less hands-on time and high reproducibility.

Sharp sample exchange enables efficient use and detailed control of sample processing.

2 x 4 sensor module enables 8 sensors to be prepared and run 2 by 4 without attendance.

- **Fully integrated turn-key system**
  This high-end QCM-D surface analysis equipment is an intuitive instrument and software platform that senses mass change, layer thickness, binding and molecular orientation at the nano-scale.
- **30 µl sample needed per sensor**
  Q-Sense Pro enables precise sample handling, ensuring effective use of samples.
- **High efficiency**
  Use the eight sensor module to program 2 by 4 experiments in flow mode or run 8 parallel measurements in stagnant mode without any need for supervision.
- **FlexiFlow feature and high reproducibility**
  High precision flow-control is ensured by using syringe pumps that work separately and allow 4 channels to be used independently. Programing automated mixing including concentration gradients of samples ensures high reproducibility.
- **Built-in temperature control**
  In the software working temperatures can be set between 4 and 70 °C enabling stable temperature control. Pre-cooling or heating of sample racks is possible.
- **Convenient for your needs**
  Save your measurement set-ups in QSoft Pro. It is easy to re-use or share your programmed sequences. Washing programs are also included and you can easily save your own cleaning protocols in QSoft Pro.
- **Combine QCM-D with other technologies**
  Q-Sense Pro is compatible with the Q-Sense Explorer. This enables you to simultaneously combine your QCM-D experiments with e.g. ellipsometry, electrochemistry or microscopy.

A The temperature stability depends on variations in how the ambient temperature affects the warming or cooling of the chamber. The specified temperature stability may not be reached if the room temperature changes more than ±1 °C, if there is a draft or a heat source nearby. The temperature of the sample solutions outside the chamber should preferably be within ±2 °C from the working temperature of the chamber.
B Smallest sample volume to pick up and dispense. Note that the smallest volume needed for measurement is 30 µl.
C Several sensor materials are available, for example, SiO_2, Titanium, Stainless steel, Polystyrene to mention a few.
D Data from 1 sensor in single frequency mode. 1 data point is collected every 5 seconds. The Sauerbrey relation is assumed to be valid.
E Data from four sensors in multiple frequency mode (3 harmonics) are collected within 1 second. The Sauerbrey relation is assumed to be valid.
F Data from four sensors in multiple frequency mode (3 harmonics) are collected within 1 second. Peak to peak value from one minute data aquisition.