TRACKING CHANGES AT THE SURFACE:

Q-Sense E4

Real-time interface characterizations

Follow molecular events in real-time
The instruments measure molecular events occurring on surfaces in real-time.

Measure mass and thickness of molecular layers
Track layers forming on the sensor surface, with nano-gram sensitivity.

Analyze structural properties of molecular layers
Detect changes in rigidity and softness of molecular layers. Quantify the viscoelastic properties of thin films; shear modulus, viscosity and density.

Flexible choice of surfaces
Includes metals, polymers and chemically modified surfaces. Any surface that can be applied as a thin film can be used.

QCM-D combination measurements
Optional modules enable simultaneous electrochemistry and humidity studies as well as other special applications.

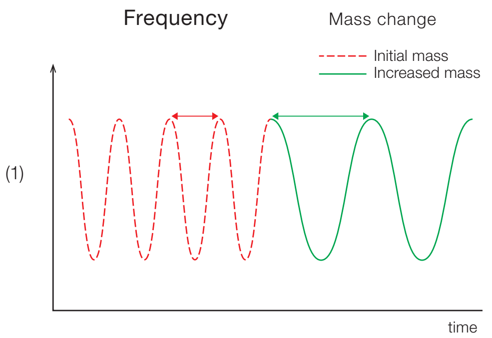
4-Sensor system
Conduct up to 4 parallel experiments in the temperature controlled chamber, designed for flow measurements.

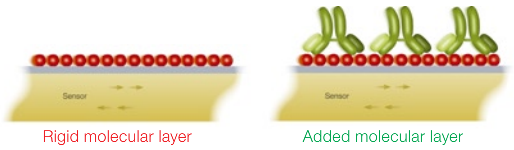
Easy to use turn-key system
Complete system includes hardware, software, hands-on training and support. We also offer webinars and workshops for data analysis guidance.

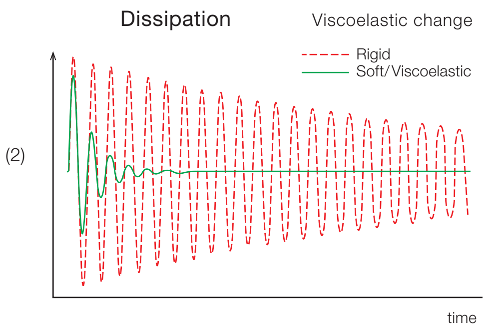
Label-free, in-situ measurements
QCM-D enables a wide range of research applications spanning from biomedical science to industrial environ-mental applications to cleaning product development.

qsense®

THE ESSENCE OF SENSING







The Q-Sense E4 is a real-time analytical instrument for studies of molecular events occurring on surfaces. The E4 measures mass and viscoelastic properties of molecular layers as they build up or change on the sensor surface. Q-Sense E4 instruments play a key role in areas such as materials, protein and surfactant research.

The Q-Sense E4 is a complete turnkey instrument including everything needed to quickly get started and produce high quality data. The instrument has four flow modules, each holding one sensor enabling four parallel measurements. There are several optional modules enabling combination measurements, such as electrochemistry QCM-D. Our product offer includes all hardware, software, support and necessary introduction and training to get you started and interpret your results.

The Q-Sense E4 instrument is based on the extremly sensitive and fast technology, Quartz Crystal Microbalance with Dissipation (QCM-D). The heart of the instrument is a sensor that oscillates at a specific frequency when voltage is applied. The frequency of the oscillation changes as the mass on the sensor changes (1). Turning off the voltage causes the oscillation to decay. The decay-rate or Dissipation factor is related to the elasticity and viscosity of the molecular layer on the sensor (2). By measuring the frequency and dissipation, it becomes possible to analyze the state of molecular layers bound to the sensor surface, their mass, thickness and structural (viscoelastic) properties.

MEASURING IS EASY

1

Mount quartz crystal sensors in the temperature controlled chamber. Four sensors are fixed in removable flow modules with liquid inlet and outlet. The quartz crystal sensors may be pre-coated with, for example, metals, polymers or SAMs.

2

Introduce sample and conduct in-situ experiments. The chosen experimental procedure is for example buffer followed by sample A and sample B and back to buffer.

3

Follow results in real time on the computer screen. Frequency changes reflect mass changes taking place on the sensor surface, dissipation changes reflect changes in the adlayer's viscoelastic properties.

4

Analyse and present results in the software QTools. Extract mass, thickness, viscoelastic properties, kinetic constants, adsorption phases and so on.

Lynn Penn at Drexel University talks about their QCM-D research

Lynn Penn's research group in the Department of Chemistry at Drexel University (Philadelphia, USA) uses QCM-D to study conformational changes caused by interaction of free species with macromolecules immobilized at surfaces. Distinct changes in frequency and dissipation occur as a result of this interaction. With the QCM-D, these changes can be followed in real-time, in situ, for extended periods.

"Using the QCM-D, we have been able to elucidate the conformational changes exhibited by both free species and immobilized layer as they interact in the flow cell of the instrument. The QCM-D curve-fitting software permits characterization of the mechanical properties of the visco-elastic layers that we study. In addition, the software allows determination of the height of the immobilized layer, which is of crucial importance in the case of polymer brushes. By using change of solvent to collapse the viscoelastic layer into an ultra-thin, elastic layer in the flow cell, we can make quantitative determinations of the mass of the immobilized macromolecules directly from the frequency change.

We use the QCM-D to study macromolecular systems in both aqueous and organic solvent systems. With it we can examine temperature stability of the layers we deposit and reversibility of the processes we observe. Because of the QCM-D's extreme sensitivity, we also use it to develop successful procedures for surface modification. The versatility of the QCM-D makes it the workhorse instrument in our laboratory. In fact, we found it so useful that we purchased two instruments."

"QCM-D is the workhorse instrument in our laboratory"

APPLYING QCM-D TO YOUR RESEARCH

Biomaterial Analysis: Mass of adsorbed proteins

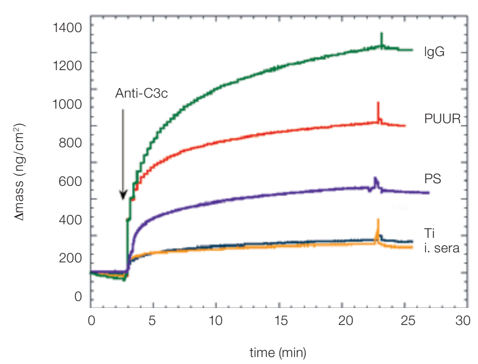
Here, QCM-D is used as a screening method for biomaterial biocompatibility and immunogenicity. Sensors coated with a variety of surface preparations were incubated with human serum containing the complement factor 3c, that induces immune responses. The amount of bound anti-C3c antibodies in the subsequent step were used as a measure of surface induced complement activation, shown in the figure. Ideal biomaterial coatings would prevent or block 3c binding. Complement activation was found on the positive control (IgG surface) and on the polymers PS and PUUR. However, the degree of anti-C3c binding on TiO_2 was as low as on the negative control (inactivated serum), indicating low immunogenicity of TiO_2.

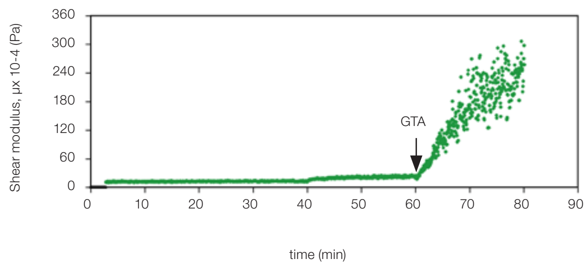
Sellborn et al. Colloids and Surfaces B: Biointerfaces 27 (2003) 295-301.

Viscoelastic properties of cross-linking macromolecules

Cross-linking of macromolecules such as polypeptides and proteins, is of great interest for example when designing interfaces in nano-fluidics and sensor technology. Here, cross-linking of Poly L-lysine (PLL) was studied as a model system. PLL was adsorbed in situ and was thereafter cross-linked with glutaraldehyde (GTA). PLL adsorbed as a soft structure but upon exposure to GTA the polymer was cross-linked, changing the viscoelastic properties of the film. The increase in the rigidity of the layer was quantified by modeling the data in QTools. The figure shows the remarkable increase in shear modulus as the layer became rigid upon cross-linking. This demonstrates that QCM-D can be used to study conformational changes, like cross-linking of macromolecules, with high precision.

Dutta et al. Journal of Colloid and Interface Science 324 (2008) 55-60.





Specifications Q-Sense E4

Specifications subject to change without notice

Sensors and sample handling system	
Number of sensors	4, also possible to measure using only 1, 2 or 3 sensors
Volume above each sensor	~ 40 µl
Minimum sample volume	~ 300 µl
Working temperature	15 to 65°C, controlled via the software, stability ±0.02 K
Typical flow rates	50-200 µl/min
Cleaning	All parts exposed to liquid can easily be removed and cleaned in e.g. ultrasonic bath
Sensor crystals*	5 MHz, 14 mm diameter, polished, AT-cut, gold electrodes
Frequency and dissipation characteristics	
Frequency range	1-70 MHz (allows 7 frequencies, up to the 13th overtone, 65 Mhz for a 5 MHz crystal)
Maximum time resolution, 1 sensor, 1 frequency	~ 200 data points per second
Maximum mass sensitivity in liquid**	~ 0.5 ng/cm^2 (5 pg/mm^2)
Normal mass sensitivity in liquid***	~ 1.8 ng/cm^2 (18pg/mm^2)
Maximum dissipation sensitivity in liquid**	~ 0.04 x 10^{-6}
Normal dissipation sensitivity in liquid***	~ 0.1 x 10^{-6}
Typical noise peak to peak (RMS) in liquid****	~ 0.16 Hz (0.04 Hz)
Software	
PC requirements	USB 2.0, XP, Vista, Windows 7
Input data, analysis software	Multiple frequency and dissipation data
Output data, analysis software	Modelled values of viscosity, elasticity, thickness and kinetic constants
Import/export	Excel, BMP, JPG, WMF, etc.

Dimensions Q-Sense E4

Dimensions	Height (cm)	Width (cm)	Depth (cm)	Weight (kg)
Electronics unit	18	36	21	9
Measurement chamber	12	23	34	8

** Several other sensor materials are available, e.g. SiO_2, Titanium, Stainless steel, Polystyrene and Biotin, to mention a few.*

*** Data from 1 sensor in single frequency mode. 1 data point is collected every 5 seconds.*

**** Data from all 4 sensors in multiple frequency mode (3 harmonics) are collected within 1 second.*

***** Data from 3 harmonics are collected in about a second. Peak to peak value from one minute data acquisition.*

ABOUT US

Q-Sense is a part of Biolin Scientific AB. Biolin Scientific is a premium instrument provider; our products are high-tech precision instrument for research within surface and material science, drug discovery and diagnostic applications. Our brands include Q-Sense, Sophion, Osstell, KSV NIMA and Attension.

Quartz Crystal Microbalance with Dissipation monitoring, QCM-D, was developed in Sweden and as a result, Q-Sense was founded in 1996. QCM-D has over a thousand publications and users such as Amgen, Boston Scientific, P&G, Harvard, Imperial College and ETH Zürich.