

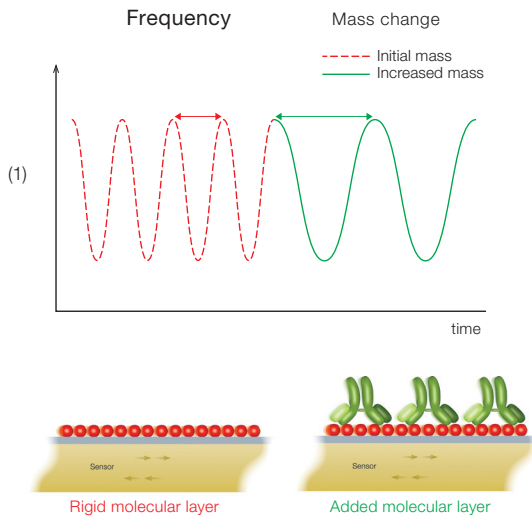
TRACKING CHANGES AT THE SURFACE

Q-Sense E4



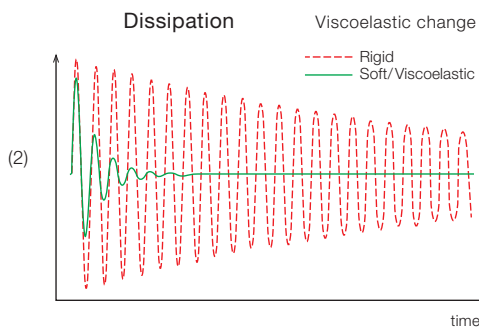
Characterization of surface interactions

- ● Measure mass and thickness
- ● Flexible choice of surfaces
- ● Real-time, label-free, in-situ method
- ● 4-sensor system
- ● Analyze structural properties
- ● QCM-D combination measurements
- ● Complete Q-Sense E4 Auto system
- ● Easy to use turn-key system



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 extremely 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

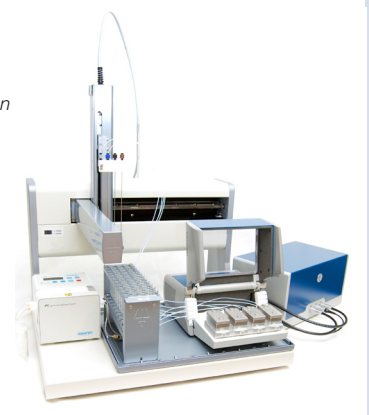
1

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.





Complete Q-Sense E4 system

This is an easy to use turn-key system. The complete system includes hardware, software, hands-on training and support. We also offer webinars and workshops for data analysis guidance. It is possible to conduct up to 4 parallel experiments in the temperature controlled chamber.

The Q-Sense E4 Auto – automatic QCM-D measurements made possible

The Q-Sense E4 Auto is a complete and automated QCM-D measurement system, which minimises the time needed to be spent by the instrument. With the Q-Sense E4 Auto, experiments are simply designed and programmed so that all steps and samples are run automatically in a controlled and precise way. The Q-Sense E4 Auto is perfectly suited for lengthy experiments, and set-ups with many different steps and sample changes such as build up of multilayer films.

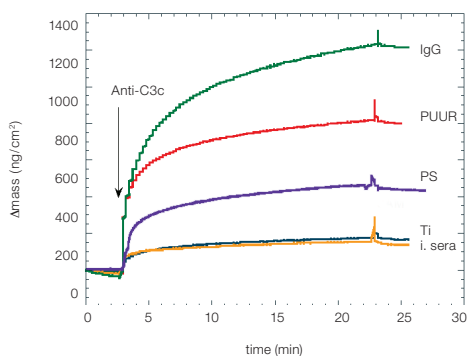
Reproducibility of measurements is another key advantage with the Q-Sense E4 Auto. Experimental set-ups are easily saved, reused and reproduced at different times, locations and between different users. This facilitates easy and exact data comparison.

The Q-Sense E4 Auto includes everything needed to run automated QCM-D measurements. The intuitive software integrates the sample handling with the QCM-D measurement. Design your experiment in QSoft and once the measurement is started, the instrument can be left without supervision.

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 TiO₂ was as low as on the negative control (inactivated serum), indicating low immunogenicity of TiO₂.

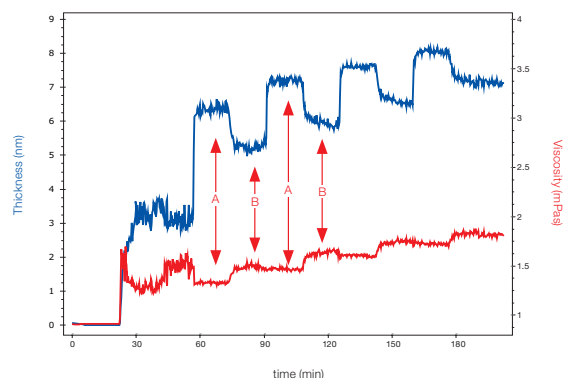
Sellborn et al. Colloids and Surfaces B: Biointerfaces 27 (2003) 295-301.



Build up and swelling of multilayer films

The Q-Sense E4 Auto is an ideal tool to characterize multilayer films because it measures the thickness of forming layers as well as swelling and viscoelastic changes. Build up of multilayers is performed in many repetitive steps and can be time consuming. The experiment was simply designed and programmed in QSoft and consisted of multilayer build up by polymer A and B and a subsequent rinse with buffer. The instrument was operated automatically for 3.5 hours, during which time, the experiment was performed without supervision. Data analysis showed that polymer A increased the thickness of the layer, whereas adsorption of polymer B increased the layer viscosity.

Measurements by Q-Sense



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

Specifications Q-Sense Autosampler, QAuto 401

Liquid handling capabilities	
Sample type	X/Y/Z with stationary racks, arm with 4 probes
Operation	Probes connected to QCM-D flow module inlets, outlets connected to pump
Arm speed	350 mm/s in X and Y dimensions, 125 mm/s in Z dimension
Number of samples, standard setup	80 (20 rows x 4) for 9 ml tubes + 44 (11 rows x 4) for 20 ml tubes
Software	
General	Allow intuitive programming of measurement sequences using the E4 and QSoft
PC requirements	USB 2.0, XP, Vista, Windows 7

Dimensions E4 and Autosampler

Dimensions	Height (cm)	Width (cm)	Depth (cm)	Weight (cm)
Electronics unit	18	36	21	9
Measurement chamber	12	23	34	8
Autosampler	57	60	54	22

* Several other sensor materials are available, e.g. SiO₂, 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 Q-SENSE

Q-Sense develops and markets real-time analysis instruments based on the QCM-D technology. Quartz Crystal Microbalance with Dissipation monitoring, QCM-D, was developed in Sweden and as a result, Q-Sense was founded in 1996. QCM-D is an established method with hundreds of publications and users such as Amgen, Boston Scientific, P&G, Harvard, Imperial College and ETH Zürich. Q-Sense instruments uniquely analyses thickness, water content and structural changes of molecular layers. Q-Sense is part of Biolin Scientific AB.



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