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DECEMBER 2009
Q-SENSE AB

A1 Product Launch: Q-Sense Ellipsometry Module

Q-Sense proudly presents the new Q-Sense Ellipsometry module, enabling combined QCM-D and ellipsometry measurements on the same surface. Read about how to measure the amount of solvent associated with molecular films.

A2 Publications – have you read any of the latest QCM-D articles?

As the use of our instruments increase, so does the number of scientific QCM-D publications. The number of articles is now approaching 600. We recently updated our publications database with new articles. Search for them at www.q-sense.com or read our summaries of a few of the latest publications.

A3 Company news

New Sensors: Borosilicate, Soda Lime Glass sensors, SiO2 ellipsometry sensor and Cellulose coated sensors.
Tips&Tricks: How to master QTools and QSoft, and tips on chemical composition
Read about upcomming events and QTools Webinars.

For further information about Q-Sense and our products please visit www.q-sense.com or e-mail us at info@q-sense.com

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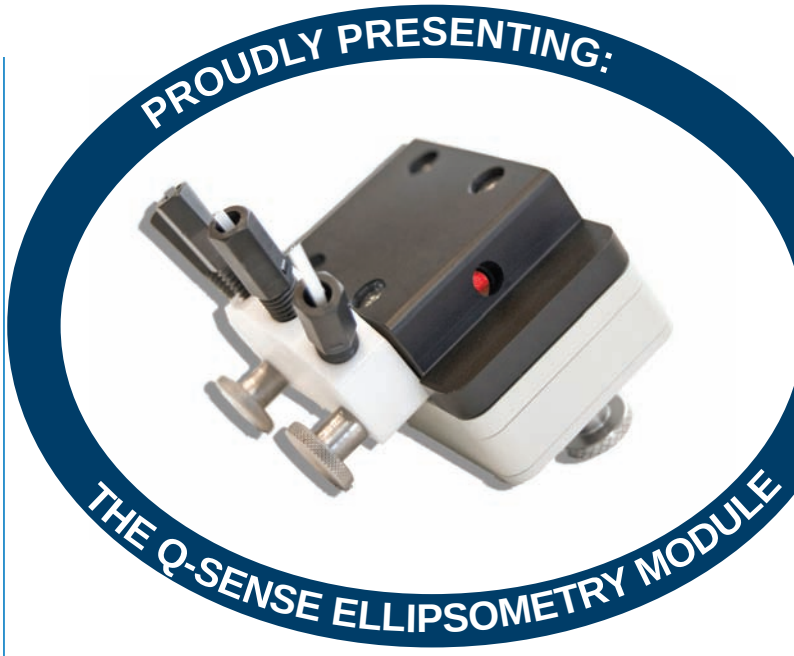
Q-Sense Ellipsometry Module

The new Q-Sense Ellipsometry Module enables combination of two real-time surface-sensitive characterization techniques, QCM-D and ellipsometry into one setup, allowing simultaneous measurements on the same sensor surface. The data output from the combined setup include mass, thickness, solvent content, viscoelastic properties, and the refractive index of thin molecular films.



Ralf Richter, research group leader in the Biosurfaces Unit at CIC biomaGUNE in San Sebastian, Spain, has used and been part of the development of the Q-Sense Ellipsometry combination module. In his group, research is focused on supramolecular self-organization phenomena in biology and biotechnology. "*The self-organization of molecules into dynamic and hierarchical supramolecular assemblies is a key feature of biological structures. The resulting architectures exhibit new qualities that are distinct from those that characterize its individual components. Our group is particularly interested in two types of assemblies: lipid membranes and the gel-like, polysaccharide-rich coats that surround many cells*", Ralf explains. At the CIC biomaGUNE both QCM-D and ellipsometry are used regularly for the biophysical in situ characterization of model systems in which self-organization processes are reproduced under controlled conditions.

"*QCM-D is today a popular method for the investigation of biomolecular adsorption phenomena at surfaces. In contrast to optical mass-sensitive techniques, which commonly detect the adsorbed nonhydrated mass, the mass measured by QCM-D includes the amount of water in the biomolecular film*", Ralf explains. A quantitative (or even mechanistic) picture of how the surrounding liquid couples to the deposited solutes has until recently remained largely elusive. With a setup that enables measurements by an optical mass-sensitive technique and by QCM-D, simultaneously and on the same support, the variations in coupled water can be quantified. "*Thanks to the combined module, we can now perform such measurements routinely*", Ralf notes.

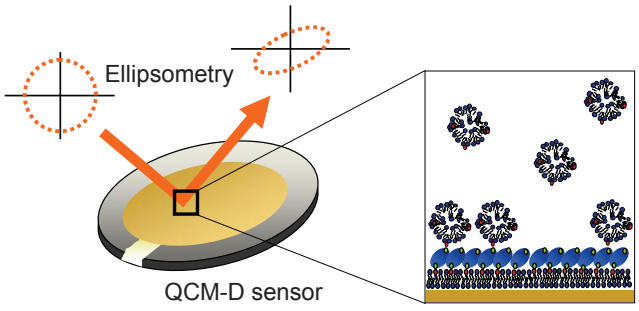


Figure 1. A setup combining QCM-D and ellipsometry was used to study a build up of lipid bilayer onto a QCM-D sensor, followed by streptavidin and vesicle binding.

A measurement example

Here, the formation of a supported lipid bilayer from small unilamellar vesicles (SUVs) containing 10% biotinylated lipids, followed by the specific binding of streptavidin, as well as biotinylated vesicles, were investigated. Changes in the resonance frequency and dissipation of the QCM-D sensor and in the polarization of the probing light beam (ellipsometry) were measured simultaneously (Fig. 1).

First, a supported lipid bilayer was formed from vesicles that attached to the QCM-D sensor (Fig.

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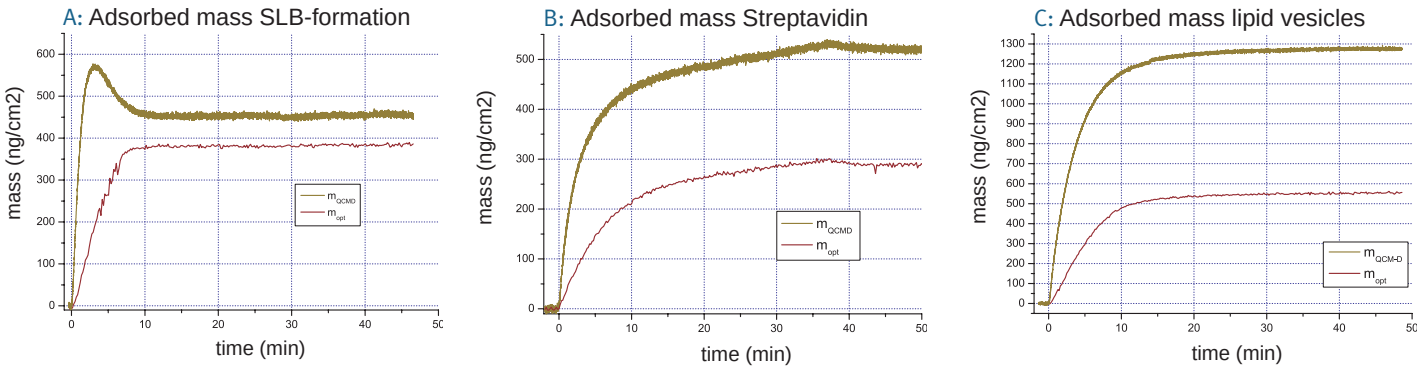

Figure 2. Masses, as detected by ellipsometery (m_{opt}) and by QCM-D (m_{QCM-D}), upon (A) formation of supported lipid bilayer, (B) subsequent binding of streptavidin and (C) intact vesicles.

2A). The bi-phasic behavior of the QCM-D mass provides a di¬rect indication that vesicles initially adsorbed intact and then ruptured to form a planar lipid bilayer. This transition is not readily visible from the ellipsometry data, which only shows a monotonous mass increase during bilayer formation. Second, streptavidin bound to the biotin groups that are exposed on the supported lipid bilayer, as indicated by the mass increases in Fig. 2B. Finally, biotinylated vesicles were again added to the streptavidin layer.

The absence of a bi-phasic behaviour in this step (Fig. 2C) provides a first indication that adsorbing vesicles remained intact. As expected, the masses determined by QCM-D (m_{QCM-D}) were consistently higher than the ellipsometric masses (m_{opt}), because QCM-D senses the solvent that is dynamically coupled to and trapped in the film. A rather small mass difference between QCM-D and ellipsometry was observed for the supported lipid bilayer (Fig. 2A), consistent with expectations for such a planar and solvent-poor structure. This can be compared to binding of the solvent filled, intact vesicles, where solvent contributes more than 50% to the QCM-D mass (Fig. 2C).

Conclusions

Combination of QCM-D and ellipsometry gives real-time, complementary data about the amount of solvent associated with molecular films. In addition to the data presented in this application note, QCM-D can provide information on mechanical properties of thin films (viscoelasticity), while ellipsometry can measure optical film properties (refractive index). Furthermore, the layer thickness can be determined with both techniques, and results compared. Thus, parallel QCM-D and ellipsometry analysis in the same setup can provide a detailed understanding of molecular events taking place at a surface.

Potential applications include

i. Measurement of time-resolved changes in the hydration of thin biomolecular films.

ii. Monitoring the build-up of polymer films, e.g., polyelectrolyte multilayers or polymer brushes, and their reaction to external cues. Swelling/collapse of the films can be easily distinguished from adsorption/desorption events.

iii. Refined analysis of adsorption processes that involve morphological changes in the adsorbed layers, e.g., the formation of supported lipid bilayers.

Did you know that Q-Sense has a SiO_2 sensor specifically designed for ellipsometry combination measurements? There is also a method description illustrating the optical characterization of Q-Sense' sensor surfaces. Please contact us for further information, at info@q-sense.com.

Have you read any of the latest QCM-D articles?

The number of QCM-D articles continues to increase, and is now approaching 600! Search and find abstracts to all of them in our publications database at www.q-sense.com. The database was recently updated with 50 new articles, below is a summary of some of them.

pH-Dependent Immobilization of Proteins on Surfaces Functionalized by Plasma-Enhanced Chemical Vapor Deposition of Poly(acrylic acid)- and Poly(ethylene oxide)-like Films

Belegrinou, S *et al*, (2008), Langmuir, 24, 7251-7261

Protein adsorption is of importance for many scientific fields, such as biomaterials, pharma and biosensor development. In this study the authors develop an adsorption scenario for four proteins (albumin, lysozyme, lactoferrin, and fibronectin) which takes into account electrostatic protein-surface and protein-protein interactions, but also the pH-dependent properties of the proteins, such as shape and exposure of specific domains. The pH-dependent adsorption of proteins on plasma polymerized PAA and PEO coatings using QCM-D was investigated. Experiments were made using Q-Sense SiO2-coated sensors. Under most experimental conditions, different stages of protein adsorption could be distinguished. The investigated proteins that differ in molecular weight and pI, generally exhibited a rapid initial adsorption phase on PAA, often followed by slower processes. Distinct adsorption regimes were also revealed in the D-f plots.

Adsorption of Crude Oil on Surfaces Using Quartz Crystal Microbalance with Dissipation (QCM-D) under Flow Conditions

Adewunmi Abudu and Lamia Goual, (2009), Energy & Fuels, 23, 1237-1248

Asphaltenes, i.e. petroleum heavy ends insoluble in n-alkanes but soluble in aromatics, have a tendency to aggregate at high concentrations and may cause problems in oil production, such as wettability alterations and fouling. The mechanisms behind asphaltene deposition on surfaces are not well-established, and in order to shine more light on this, the authors investigated crude oil-surface interaction behaviors using QCM-D under flow conditions, where measurements in different solvents (toluene and n-alkanes) were analyzed in terms of thickness, viscoelasticity, Langmuir behavior, saturation plateaus for different particle sizes, and other key aspects of asphaltenes' chemical nature.

Adsorption of Pluronic F-127 on Surfaces with Different Hydrophobicities Probed by Quartz Crystal Microbalance with Dissipation

Nejadnik, M.R *et al*, (2009), Langmuir 25(11), 6245-6249

PEOn-PPOm-PEOn triblock copolymers, better known as Pluronic, are used in a variety of applications for their repellence to protein adsorption and bacterial adhesion. Depending on the hydrophobicity of the substratum surface, they display different degrees of inertness, which is related to their conformation: on hydrophilic surfaces the copolymers adsorb in a "pancake" conformation, reducing protein adsorption partially, while as on a hydrophobic substrate, they form a brush, which completely inhibits protein adsorption. In this study, the threshold hydrophobicity between the two adsorption formations was sought for. Through a series of substrates measured by QCM-D, including hydrophobic and hydrophilic gold and SAM surfaces, the authors found a surface contact angle above 80° to yield a brushlike conformation, as inferred from differences in thickness, viscosity and shear elastic modulus.

QCM-D studies of human norovirus VLPs binding to glycosphingolipids in supported lipid bilayers reveal strain-specific characteristics,

Rydell GE, *et al*, (2009), Glycobiology 19(11) 1176–1184.

Norovirus has been estimated to cause up to 200 000 deaths of children annually, and here QCM-D was used to study Norovirus virus-like particles adhesion and binding kinetics to glycosphingolipids in fluid supported lipid bilayers (SLB). As there is a lack of effective cell cultures for norovirus, in vitro studies using VPLs are common, and glycosphingolipids in fluid SLB are used as a model cell membrane. Here, QCM-D is used for the first time to study interactions between the virus and lipidlayer and QCM-D studies may become a valuable tool to assay inhibitors of virus attachment.

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Company News

Tips & Tricks

Want to measure in organic solvents?
Q-Sense offers chemically resistant sealing materials and soft pump tubing that resists even harsh organic solvents like Toluene and Hexane. In Q-Sense standard flow module (QFM 401), there are Kalrez® o-rings and gaskets available. Further, the standard pump tubing needs to be replaced by a so-called GORE® Type 100 CR which has excellent compatibility with e.g. Toluene even though the tubing is soft enough to be used in peristaltic pumps. The standard Teflon®, tubing included with all E-series instruments, is resistant to organic solvents.

QTools – small tips to master your anlysis
1. *Did you know that you can monitor the stabilization of the chamber temperature before starting a measurement?* Go to “Show preacquisition form” in the Tools menu, to see the temperature curve. Here, you can also start making experimental notes, which will be automatically transferred into the notes window when the measurement is started.

2.*While fitting data in QTools, you cannot compare ChiSquare between datasets – it shuold only be used to monitor the progress within one modelling session.* ChiSquare is not related to the number of data points included, so a file twice the size of another, will give twice as large ChiSquare for an equally good fit.

3. *Did you know that you have to include the non-coated sensor’s baseline in your calculations to analyze a film applied ex-situ?* If you need to coat your sensor ex-situ, start by saving a short baseline measurement with the bare sensor, then coat it ex-situ, perform your measurement, and merge the data sets afterwards by using the stitching function in QSoft.

For further tutoring on QTools, join our free Q-Tools Webinars. These will give you an opportunity to learn how to analyze and quantify your data by walking through a live analysis in QTools together with one of our application specialists. All you need is speakers/headphones and an internet connection! Check our calender for upcoming sessions.

New Sensors

Borosilicate and Soda Lime Glass sensors
We now offer Borosilicate and Soda Lime Glass coated sensor. These glass materials are common in vials and of interest to protein-container interaction studies.

SiO_2 ellipsometry sensor
SiO_2 sensors specifically designed for ellipsometry combination measurements are now available. The sensor has a thicker layer of titanium to enable a safer characterization of the optical properties of the different layers.

Cellulose coated sensors
Our cellulose sensor is a representative model surface of native cellulosic fibers, thanks to the native type of cellulose used during coating.

Please contact us for further information and purchase details, sales@q-sense.com.

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Upcoming Events

Fresh start for 2010 QTools webinars:
Get the basics of data analysis including adsorption, stitching files together, and degradation analysis. Pick your date in the calendar:

QTools Webinars:

Jan 28, 10.00 AM Central European Time
Feb 23, 3.00 PM CET
Mar 17, 10.00 AM CET
Apr 19, 4.00 PM CET
May 19, 9.00 AM CET

Meet us at conferences:

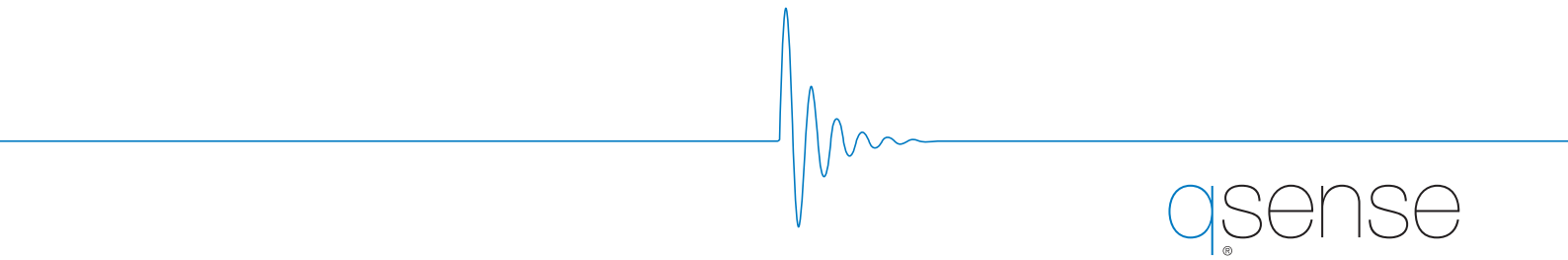
Feb 20, 2010 - San Francisco, CA
Biophysical Society Annual Meeting 2010

Mar 10, 2010 - Düsseldorf, Germany
Detergents and Cleaning Products
Hans Uddenberg invited speaker “Real-time nanoscale evaluation of cleaning efficiency using QCM-D”

Mar 21, 2010 - San Francisco, CA, USA
239th ACS National Spring Meeting

Apr 7, 2010 - Göteborg, Sweden
Annual European Rheology Conference

Apr 7, 2010 - Siegen, Germany
PolyChar 18 - world forum for advanced materials. Learn about QCM-D in the Short Course included in the conference.



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