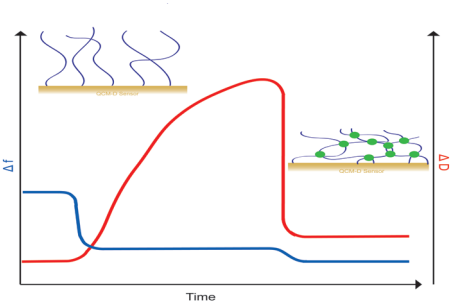
POLYMER STUDIES BY QCM-D

Polymers are versatile building blocks within applications ranging from plastics used in everyday life to sophisticated biopolymers for medical devices. Quartz Crystal Microbalance with Dissipation monitoring, QCM-D, has been used for the characterization of a wide variety of polymers.

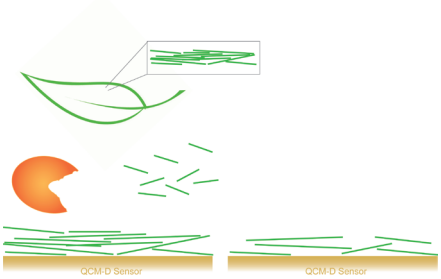
Control of polymer build-up, conformation and degradation are key features in the study and development of polymer based materials. QCM-D provides this control through measuring changes in both mass and softness (related to energy dissipation) of polymer layers in real-time.



Biopolymer grafting and cross-linking through specific interaction [1]

Hyaluronan is one of the most abundant polymers in the extracellular matrix and it is of great interest to see how it interacts with biomolecules. In this study the focus was on the inflammation related protein TSG-6 and how this cross-links hyaluronan. The dramatic decrease in the QCM-D signal showing energy dissipation (Fig. 1) at TSG-6 exposure made the authors determine that hyaluronan collapses into a stiffer film when interacting with TSG-6. This provides valuable understanding of how the structure of the extracellular matrix is remodeled during inflammatory processes.

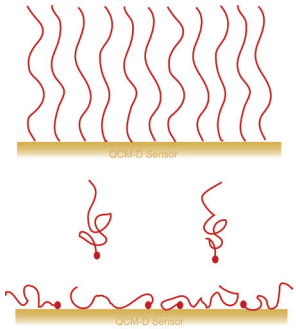
FIGURE 1. Illustration showing the frequency and dissipation shifts as hyaluronan (blue in illustration) is immobilized and later cross-linked by tumor necrosis factor-stimulated gene-6 (TSG-6) (green ovals).



Degradation of cellulose for biofuel applications [2]

Enzymatic degradation of cellulose is an attractive way to produce biofuels as an alternative to fossil fuels. Here QCM-D was used to study the enzyme binding dynamics and to quantify the rate and level of degradation of different types of cellulose. From the QCM-D data it was elucidated that the cellulose films became softer and more hydrated in the degradation process. This information provided valuable insight into the underlying mechanisms to cellulose degradation which contributes to the development of more efficient biofuels.

FIGURE 2. Illustration of cellulose on a QCM-D sensor and degradation by the enzyme cellulase.



Grafted polymer conformation and phase transition [3]

Polymers grafted to a surface can adopt several different conformations. The ability to control these transitions increases the applicability of the material. In this study QCM-D was chosen specifically for the sensitivity of the technique to study changes in polymer conformation. It was possible to control the conformation of the polymers in situ and in real-time by altering temperature and grafting density and also to identify different phases in the polymer adsorption process.

FIGURE 3. Illustration of polymers adsorbing in a brush (top) or pancake (bottom) conformation.

REFERENCES

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[3] Zhang, G., Wu, C., *Quartz crystal microbalance studies on conformational change of polymer chains at interface*. Macromolecular Rapid Communications, 30 (4-5), 328-335, 2009