Biolin Scientific
[Progress Together]

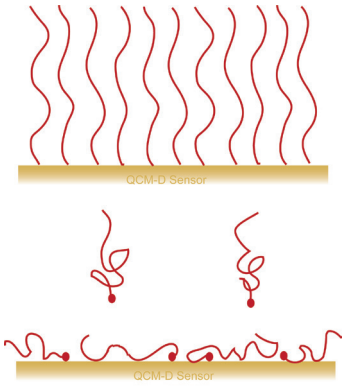
Q-Sense | [Application Overview] 2

Polymer studies by QCM-D

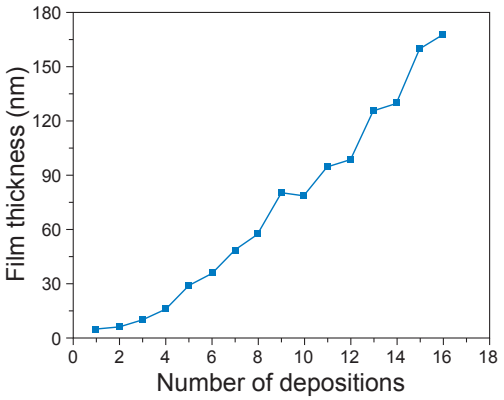
Polymers are versatile building blocks within applications ranging from plastics used in everyday life to sophisticated biopolymers for medical devices. Quartz Crystal Microbalance with Dissipation monitoring, QCM-D, has been used for the characterization of a wide variety of polymers.

Introduction

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.



[Figure 1]: Illustration of polymers adsorbing in a brush (top) or pancake (bottom) conformation.



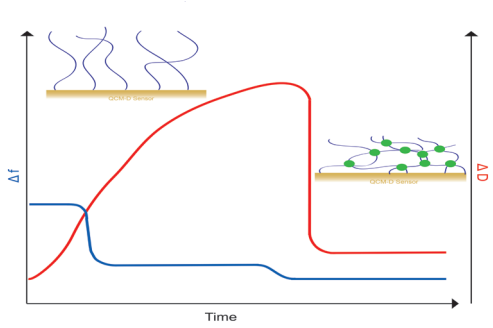
[Figure 2]: Thickness of multilayer after each polyelectrolyte deposition, measured with QCM-D.

Grafted polymer conformation and phase transition [1]

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.

Build-up and control of polyelectrolyte multilayers [2]

Polyelectrolyte multilayers are used to modify surfaces in a vast number of applications thanks to their flexibility and robustness. Even though they are simple to build, the mechanisms of how different conditions affect the build-up is not well understood. QCM-D is an ideal tool to get better understanding of this as it can study the build-up of hydrated films in real-time. In this study polyelectrolyte multilayers were evaluated in terms of thickness per layer and the influence of salt concentration on build-up rate and total thickness.



[Figure 3]: 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).

Biopolymer grafting and cross-linking through specific interaction [3]

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. 3) 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.

References:

[1] 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

[2] Zan, X., Peng, B., Hoagland, D.A., Su, Z., Polyelectrolyte uptake by PEMs: Impact of salt concentration. Polym. Chem., 2, 2581-2589, 2011

[3] Baranova, N. S., Nilebäck, E., Haller, F. M., Briggs, D. C., Svedhem, S., Day, A. J., Richter, R. P., The inflammation-associated protein TSG-6 cross-links hyaluronan via hyaluronan-induced TSG-6 oligomers. J. Biol. Chem., 286 (29), 25675-25686, 2011