

QCM-D AND NANOPARTICLES RESEARCH

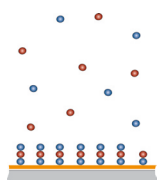
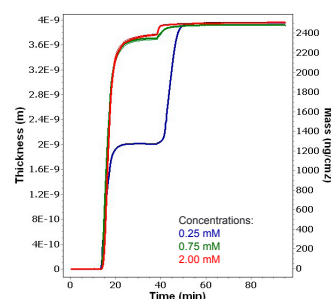
Nanoparticle analysis is a rapidly growing research area with applications in a variety of fields including energy, nanocomposite materials, the environment and healthcare. Nanoparticles are being incorporated into materials such as solar panels, nanomachines, and a variety of thin films and coatings to generate more desirable properties. Although their use and benefits are unquestioned, there are still potential risks in their widespread use to health and the environment. Therefore, there is a need for new techniques for characterizing nanoparticles including their interactions with surfaces, each other and their stability in the environment. Quartz Crystal Microbalance with Dissipation Monitoring (QCM-D) is an analytical technique that provides in-situ analysis of interactions taking place at surfaces.

QCM-D applications:

QCM-D analysis reveals changes in molecular mass, as measured by changes in frequency of the quartz sensor (Δf), upon which reactions take place and are measured. In addition QCM-D measures the energy dissipation (ΔD) which provides novel insights regarding structural (viscoelastic) properties before, during and after the interaction. This technique enables one to study nanoparticle self-assembly processes, nanocomposite materials and track nanoparticle interactions in the environment.

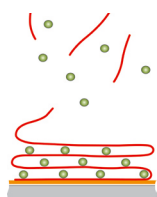
Thickness and mass vs. time plot

Adsorption of 1:1 Au:Ag nanoparticles at various conc. Au nano particles were functionalized SAM of mercaptoundecanoic acid and Ag nano particles were functionalized with N,N,N-trimethyl(11-mercaptoundecyl) ammonium chloride. Flow stopped 17-38 min to study the adsorption in stagnant mode.



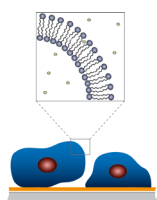
Self assembly processes.

Self-assembly is a process where similar particles spontaneously bind to one another to form new materials, coatings or films with a variety of desirable properties. The QCM-D technology enables one to measure the *kinetics of nanoparticle self-assembly processes*, measure the resulting *thickness, mass and structural properties* of the self-assembled film and *compare* the self-assembly process under *different conditions* such as temperature, solvent type or concentration, flow or static environment and particle type.



Nanocomposite materials analysis.

Modifying polymer films with nanoparticles to form nanocomposite materials has become a useful method to modulate the structural properties and other characteristics of thin films to have more desirable properties and better stability. The QCM-D technology can be used to study changes in film thickness and rigidity due to the additional of nanoparticles. Properties such as *thickness, viscosity, storage and loss modulus* of nanocomposite materials can be measured, in real time, by QCM-D.



Nanoparticle interactions in the environment.

There is concern that nanoparticles stable in the environment could cause significant health issues. The QCM-D technology can also be used to *track nanoparticle stability and interactions* under environmental conditions with a variety of real-life surfaces such as glass, metals and natural organic matter. The technique can *track the kinetics, extent and stability of nanoparticle deposition* onto different surfaces and in different environmental conditions.

To summarize, the QCM-D technology is a useful analytical tool for measuring nanoparticle interactions with surfaces, self-assembly processes and nanocomposite materials.