December 28, 2013

Re: Final report for RERF Award: “Quartz Crystal Microbalance with Dissipation (QCM-D)”

Proposal Title: Quartz Crystal Microbalance with Dissipation (QCM-D)
Principal Investigator: Karl F. Schilke, PhD
Department: School of Chemical, Biological and Environmental Engineering (CBEE)
College: College of Engineering
Award Information: RERF award, May 9, 2013, $60,000

Budget Statement:

The RERF award of $60,000 was supplemented by unrestricted research funds ($52,847) from the PI’s departmental start-up package, for a total amount of $112,847. This was used to purchase a Q-Sense E4 Quartz Crystal Microbalance with Dissipation (QCM-D) instrument with a 1-year service agreement, a training travel stipend, a UV/ozone cleaner, and standard accessories (see the attached quote). The QCM-D instrument arrived on 5/30/2013, and has been operational in Gleeson 300 since 6/15/2013.

Summary of Scholarly Activities Enabled by RERF Funding:

The QCM-D system has received a considerable amount of use and interest in the last 6 months. During the summer, we hosted an intensive, two-day training workshop (9/4-9/5/2013) by Matthew Dixon, a staff scientist from Q-Sense. During this workshop, 11 students (5 undergraduate) from the PI’s lab and across campus received hands-on training on setting up QCM-D experiments and analyzing their results.

QCM-D has already become a staple technique in our lab for measurement of the interactions between surface coatings and proteins, cells, etc. In particular, two of our PhD students have been using the QCM-D extensively in their dissertations. One student’s work involves analysis of the binding of bacterial endotoxin and proteins to surfaces coated with tethered antimicrobial peptides. This system shows potential for rapid treatment for sepsis and other blood-processing applications. A manuscript describing these results is currently under preparation, tentatively titled “Binding of bacterial endotoxin and interactions with fibrinogen by a tethered antimicrobial peptide”. We plan to submit this manuscript in January 2014 to Acta Biomaterialia or Biomaterials. This work (and much unpublished QCM-D data) represent the final chapters of this student’s dissertation, to be defended in Winter 2014.

Data from the QCM-D system contributes key experimental evidence in support of our recent report of the concentration-dependent changes in elution of peptides entrapped in a polymer brush layer. A manuscript, entitled “Concentration effects on peptide elution from pendant PEO layers”, is currently under review at the journal Colloids and Surfaces B: Biointerfaces. This work has relevance in the design of drug-delivery strategies and biofunctional materials, and represents a major chapter in a PhD dissertation on mechanisms of entrapment and elution of peptides from pendant polymer brushes, also to be defended in Winter 2014.
In addition to the current and on-going graduate work in our lab using the QCM-D, we have listed the instrument (and our complementary OWLS system) as an OSU Shared Research Facility, and encourage collaboration with PI's in our department and from around campus. Experiments using the QCM-D have already been performed by graduate students from CBEE, Physics and Biochemistry/Biophysics, and we look forward to other such opportunities to support our colleagues' research efforts in the future.

Summary of External Funding Enabled by This RERF Award:

Although we have had it only a short time, the QCM-D instrument, especially in conjunction with the complementary OWLS technique already in our lab, has contributed to our external funding.

In particular, a recent proposal which was funded by the OHSU Medical Foundation of Oregon ($40,000, 10/24/2013) specifically involves the use of QCM-D to monitor the capture and degradation of bacterial cells and endotoxin at coated surfaces. The unique “dissipation mode” of the Q-Sense QCM-D instrument enables more in-depth analysis of the mechanism of endotoxin binding and disruption by peptide-coated surfaces.

Substantial amounts of data on interactions of antimicrobial peptides with endotoxins and blood proteins have been acquired using QCM-D over the last three months. These results will be used as preliminary results to support proposals which will be submitted in early 2014. In particular, we intend to include QCM-D data showing the strong and fast binding of bacterial endotoxins by antimicrobial peptides in a multi-PI NIH R21 proposal, targeted for submission in February 2014. This proposal will seek to demonstrate a highly-efficient, microfluidic approach to maximize the binding of endotoxins from flowing blood by tethered antimicrobial peptides. Preliminary data generated by this work will be used to support proposals to develop prototype devices, and to further develop and optimize our coatings.

Although we have only just begun to understand and use the more powerful features of the new QCM-D instrument, it has already had a profound effect on our ability to understand the interactions of proteins, nanoparticles, vesicles, etc. with surfaces. Not only does the QCM-D directly support my research program, it also offers many exciting opportunities to collaborate with other groups across campus. I am deeply grateful for the generous support through the RERF program.

Sincerely,

Karl Schilke

Karl F. Schilke
Assistant Professor
Chemical Engineering
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