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Surface Plasmon Resonance/Quartz Crystal Microbalance – Annotated Bibliography

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**Literature**

**1.** **Vaish, A., S. B. Guo, et al. (2018). "On-chip membrane protein cell-free expression enables development of a direct binding assay: A curious case of potassium channel KcsA-Kv1.3." Analytical Biochemistry 556: 70-77.**

 Demonstrated here is a method of expressing stabilized and functional integral membrane proteins onto an SPR chip (both functionalized with antibodies and bound directly and incorporation into surface supported lipid bilayers). They used a cell-free expression system, TX-TL, with the trick of using sfGFP to assist in correctly folding the protein into its native tetramer structure. The protein used in the study was the chimeric ion channel, KcsA-Kv1.3 (K-K). Anionic phospholipids were found to be essential for correct folding. The direct method of antibody attachment was the method that was found to interact with K-K’s binding partners. The bilayer incorporation method led to integration upside down.

**2. Knoll, W., I. Koper, et al. (2008). "Tethered bimolecular lipid membranes - A novel model membrane platform." Electrochimica Acta 53(23): 6680-6689.**

 This paper describes the design, assembly and characterization of tethered lipid bilayers for biosensor development. Thiol coupling to the gold SPR chip enables a lipid monolayer to be covalently bound and then vesicles flowed over the chip to make bilayers by vesicle fusion. SPR, QCM and electrochemical spectroscopy characterization was performed. It was shown that tethered bilayers could reach electrical resistance of more than 10 MΩ/cm2. Additionally, using a His-tag with a NTA/Ni2+ approach enabled correct orientation of the protein into the bilayer. Valinomycin administration into the bilayer demonstrated notable potassium translocation. These methods are widely applicable to a large variety of membrane associated proteins for incorporation and characterization with lipid bilayers.

**3. Cooper, M. A. and V. T. Singleton (2007). "A survey of the 2001 to 2005 quartz crystal microbalance biosensor literature: applications of acoustic physics to the analysis of biomolecular interactions." Journal of Molecular Recognition 20(3): 154-184.**

 This review highlights QCM literature of the utmost impact during the early 2000s biosensor boom. Starting with the exploitation of SPR in the mid-90s, piezoelectric acoustic sensors have been the method of practice for determining binding affinities, kinetics and conformational changes from molecular recognition events. The review highlights interfaces using proteins, bacteria, lipids, viruses and small molecules.

**4. Glatz, R. and K. Bailey-Hill (2011). "Mimicking nature's noses: From receptor deorphaning to olfactory biosensing." Progress in Neurobiology 93(2): 270-296.**

Techniques of SPR, QCM, patch-clamp electrophysiology and EOG are described here in works that demonstrate olfactory receptor deorphaning and utilizing cell extracts to express odor receptors for biosensing.

**5. Homola, J., S. S. Yee, et al. (1999). "Surface plasmon resonance sensors: review." Sensors and Actuators B-Chemical 54(1-2): 3-15.**

This review highlights the major developments in SPR until 1999 and describes methods for quantifying biomolecular interactions.

**6.** **Vidic, J., J. Grosclaude, et al. (2008). "On a chip demonstration of a functional role for odorant binding protein in the preservation of olfactory receptor activity at high odorant concentration." Lab on a Chip 8(5): 678-688.**

**7. Sanmarti-Espinal, M., P. Iavicoli, et al. (2017). "Quantification of interacting cognate odorants with olfactory receptors in nanovesicles." Scientific Reports 7.**

Papers six and seven utilize SPR in order to quantify odor receptor interaction with odor binding proteins and odorants. In both papers, yeast is utilized to express ORs on the surface.

**8. Cho, N. J., C. W. Frank, et al. (2010). "Quartz crystal microbalance with dissipation monitoring of supported lipid bilayers on various substrates." Nature Protocols 5(6): 1096-1106.**

Zwitteronic phospholipid bilayers are constructed onto the surface and lipid-protein, protein-protein for biosensing applications. Consideration for anionic phospholipids is also taken into account. This method enables real-time kinetic monitoring.

**9.**  **Richter, R. P. and A. R. Brisson (2005). "Following the formation of supported lipid bilayers on mica: A study combining AFM, QCM-D, and ellipsometry." Biophysical Journal 88(5): 3422-3433.**

 Characterization of lipid bilayer formation based on the type of solid support. This study combines surface characterization techniques with that of quartz crystal microbalance with dissipation. The presence of calcium was found to have more influence on bilayer structure on mica compared to those on silica.

**10. Calakos, N., M. K. Bennett, et al. (1994). "Protein-Protein Interactions Contributing To The Specificity Of Intracellular Vesicular Trafficking." Science 263(5150): 1146-1149.**

Intracellular vesicles have signals to fuse to their target. It is shown here a suggested mechanism through which this occurs. The vesicle membrane protein VAMP 1 and 2 bind to acceptor membrane proteins syntaxin 1A and 4. The dissociation constant is 4.6 µM.

**Web Resources**

1. https://timothyspringer.org/files/tas/files/biacore3000-sensorsurface.pdf

 - The best commercially available SPR handbook from Biacore

2. <https://www.youtube.com/watch?v=o8d46ueAwXI>

 - Biacore video demonstrating the application of SPR

3. <https://www.youtube.com/watch?v=sM-VI3alvAI>

 - SPR explained – Youtube Video

4. <https://www.youtube.com/watch?v=kzmBK9mONq8>

 -Principle of Quartz Crystal Microbalance

5. <https://www.electronics-tutorials.ws/oscillator/crystal.html>

 - Quartz crystal oscillators

6. <https://www.sprpages.nl/spr-overview/spr-theory>

 - History and brief introduction into SPR

7. <http://biosensingusa.com/technologies/surface-plasmon-resonance/surface-plasmon-resonance-work/>

 - SPR website

8. <https://www.gelifesciences.com/en/ch/solutions/protein-research/knowledge-center/surface-plasmon-resonance/surface-plasmon-resonance>

 - Biacore’s website for learning how to use SPR

9. <https://chem.uiowa.edu/sites/chem.uiowa.edu/files/people/shaw/140402%20-%20JSG%20-%20QCM.pdf>

 - Student presentation on how QCM works

10. <https://www.sciencedirect.com/topics/food-science/quartz-crystal-microbalance>

 - QCM topics