# A Sol-Gel Model for Protein Delivery from the Surface Microelectrodes

Matthew D McDermott[1, 2], Anna Filley[2], Kevin J Otto[2, 3]
[1]Interdisciplinary School of Biomedical Sciences, Purdue University
[2]Weldon School of Biomedical Engineering, Purdue University
[3]Department of Biological Sciences, Purdue University

**Statement of Purpose:**
Tetraethyl Orthosilicate (TEOS) have been successfully used as thin coat polymers for drug delivery[1]. Tetramethyl Orthosilicate (TMOS) coatings have successfully increased CV and lowered impedance on microelectrode devices[2]. But can they also be used to deliver drugs or proteins? When microelectrodes are implanted into the brain, the foreign body response causes inflammation and swelling, which can negatively impact the recording ability of the device. Localized delivery of a drug or protein to mitigate this offers a solution to this problem. The use of TMOS has multiple benefits for its use as a microelectrode coating. This study aims to create a protein delivery model to analyze the ability of multiple layers of TMOS to be used for acute protein delivery from a silicon surface, in order to determine release kinetics and surface properties of the coating in a cost efficient manner.

**Methods:**
Sol-Gel formation was accomplished by mixing TMOS with acidified water, after which various concentrations of BSA protein were added with Phosphate Buffer. A micro-actuator was used to thin coat silicon wafer chips with multiple layers of Protein/ Sol-Gel mixture. Release studies were performed at 37°C in Phosphate Buffered Saline to analyze release kinetics. Two analyses were performed: one to analyze the effect altering the coating composition paradigm, Protein containing Sol-Gel Coatings (PC) and Non-BSA containing Sol-Gels (NC), upon release. The second analysis observed the effect of protein concentration upon release. Protein release was analyzed using a spectrophotometer at 595nm and a Coomossie Blue Assay. The

**Results:** The elution studies showed that increasing the number of BSA/Sol-Gel layers did not allow for the release of protein for more than 24-hours. However, by coating wafers with a Non-BSA Containing Sol-Gel coating, after having layered multiple coatings of Protein containing Sol-Gel, protein release occurred for up to 6 days (Figure 1).
It was also observed that altering the BSA concentration of the Protein containing Sol-Gel Coating increases the amount of BSA delivered from the wafer, but does not affect the duration of release (Figure 2).

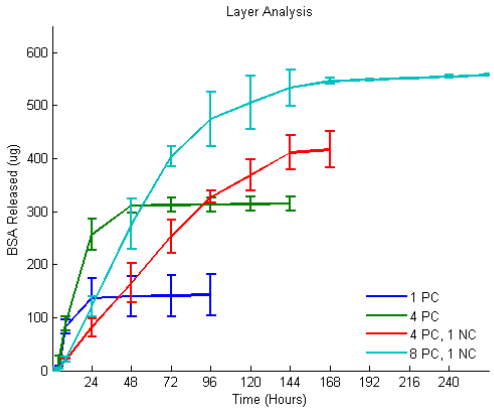


Figure 1. Effect of Coating Paradigm on Release

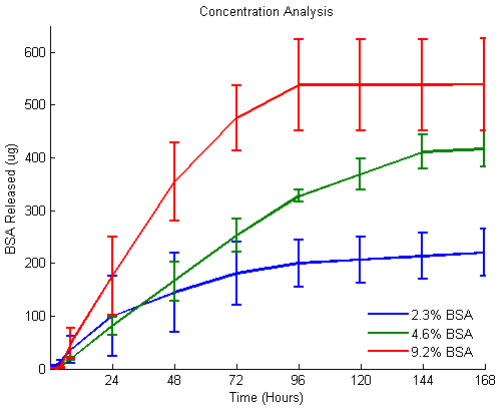


Figure 2. Effect of Altering Concentration of 4PC, 1NC Paradigm on Release

**Conclusions**
Results show that by adjusting the concentration of the protein in the Sol-Gel mixture and the number of surface layers applied, it is possible to control the release kinetics from the silicon surface. These results show promise for the use of TMOS as a delivery vehicle for protein *in vivo* across the brain-microelectrode interface to mitigate inflammation. Further studies need to be conducted to analyze the effects of simultaneous release of immune-modulating compounds, such as multiple drugs and/or proteins; analysis of the maximum number of coatings that can be applied to the silicon surface before loss of the coatings' structural integrity occurs.

**References:**
1. Radin S., Biomaterials, 2007. 28: p. 1721-1729.
2. Pierce A. L. Journal of Neuroscience Methods, 2009. 180(1): p. 106-110.