Developing Novel Biosensors for PFAS Constituents

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Background/Objectives. Samples from sites contaminated with emerging contaminants like per- and polyfluoroalkyl substances (PFAS) must be sent for off-site analysis in to order measure contamination levels. Current analytical methods mostly employ lab-based liquid chromatography mass spectrometry (LCMS) which have the advantage of high sensitivity and low detection limits but suffer from being expensive, time-intensive (usually 2 to 3 weeks turnaround time), and require specialized personnel for operation. While this is inconvenient for site characterization and limits the ability to perform a "triad"-style expedited approach, it is even more troublesome when it comes to measuring treatment system effluent because exceedances will not be known for weeks after the sample is collected. Portable tools that can allow for real-time, inexpensive measuring of contaminants in the field are therefore highly desirable.

Approach/Activities. A program is underway to develop biosensors that enable in-field, or non-laboratory based, detection of PFAS. The objective is biosensor-based detection that is sensitive and specific without interference from non-target PFAS compounds or common PFAS co-contaminants. Three parallel biosensor strategies are being employed: a whole-cell biosensor (WCB), a bioaffinity reagent biosensor (BRB), and an antibody-based biosensor (ABB). Due to the typically higher limits of detection (LODs) of WCBs, a relatively lower probability of success with sufficient sensitivity for in-field detection without the inclusion of pre-treatment and sample concentration might yield the method impractical. In contrast, literature precedent suggests BRBs can achieve PFAS LODs in the ppt range when used in the context of surface plasmon resonance-based optodes (Cennamo et al. 2018). Accordingly, Allonnia's BRB work aims to deliver sensors that bind target PFAS with sufficient affinity and specificity to enable PFAS detection in the ppt range. A highly diverse library of about 10^{13} protein variants with the potential for PFAS binding has been constructed and is currently being screened. Multiple rounds of selection, kinetic characterization of enriched BRB PFAS binding affinity and specificity, and optimization of the best PFAS-specific BRBs are expected.

Results/Lessons Learned. In this presentation we will describe Allonnia's approach to development of versatile biosensor tool that fulfils an unmet market need. Biosensors can convert a bio-signal from a highly specific interaction between the target contaminant and into a measurable electrochemical response to detect contaminants with high sensitivity. Biosensors have the potential to be developed as easy to operate, robust, rapid (short response time), and portable detection tools with high selectivity and specificity. Biosensors are more efficient and economical as they allow for direct detection of the analyte without pretreatment or with minimal sample pretreatment and eliminate the costs associated with sample shipment.