GROUP 2

A Novel Polymer-based PFAS Sensing Technology

Areen Banerjee, Michael Shreve, Dayal Saran, Kent Sorenson [Allonnia LLC], Scott Witte, Ron Levin, Andre Tatar [Salvus LLC]

ABSTRACT/OVERVIEW

Per- and Polyfluoroalkyl compounds are a class of substances that have found use in industrial and commercial manufacturing over the last six decades. In April 2024, the EPA announced a national Primary Drinking Water Regulation establishing Maximum Contaminant Levels for six PFAS compounds: PFOA, PFOS, PFNA, HFPO-DA (commonly known as GenX), PFHxS, and PFBS. These levels are based on recent studies showing the potential for deleterious effects of PFAS on human health and the environment. Existing market estimates place the size of the environmental liability in the US at over $160 billion.

The current process for the detection of PFAS compounds in groundwater includes collecting water samples and sending them to labs for analysis and certification. This testing procedure takes weeks to complete. The new EPA analytical method along with the sheer volume of samples causes this process to be expensive and time-consuming.

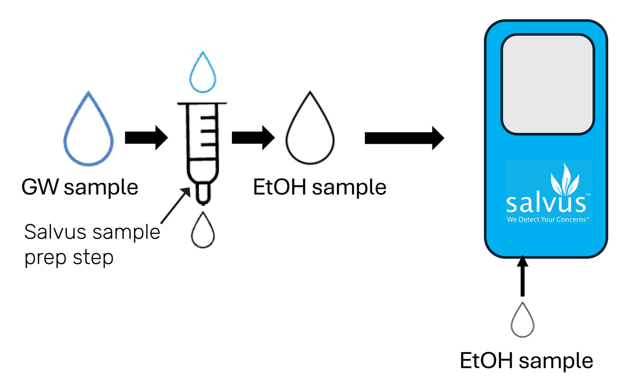
An urgent need exists for a field-ready/hand-held detection system that can quickly measure PFAS compounds at the site and provide relatively accurate results in real time. Allonnia, Salvus, and Georgia Tech have teamed up to investigate the development of a polymer-based PFAS sensing system that uses Salvus' interferometry detection platform.

SALVUS DETECTION PLATFORM

Figure 1: Salvus handheld platform showing positive test result for PFAS detection.

THE PATH TO PPT DETECTION

Salvus field sample treatment for PFAS extraction. Salvus currently has 2 paths to PFAS detection in the parts per trillion range. Sample preparation methods are currently being developed and optimized to be done in the field with little to no need for lab equipment. This will result in a rapid, easy-to-use extraction method that delivers PFAS detection results in minutes and hours rather than days and weeks.

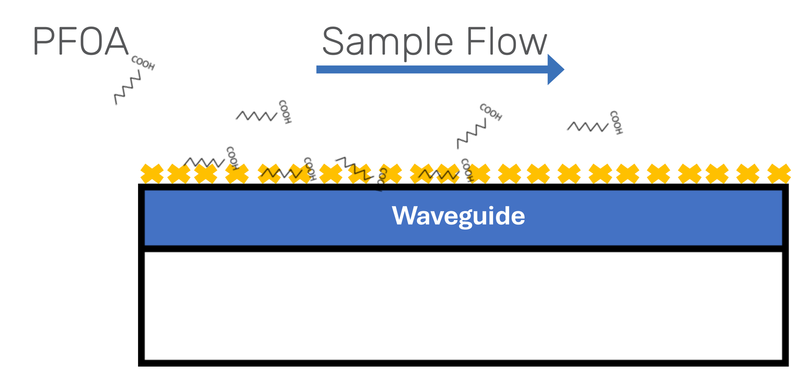


POLYMER-BASED PFAS RECEPTOR

Polymer Coating 1: PFAS adsorbing receptor

Coating Charactertistics:

- Detection directly in water (No need for buffer exchange)
- Quantitative @ 100ppb
- Reusable



Polymer Coating 2: PFAS binding receptor

Coating Charactertistics:

- Detection in EtOH
- Buffer exchange allows for preconcentration and interference removal from matrices
- Quantitative @ 100ppb
- Reusable

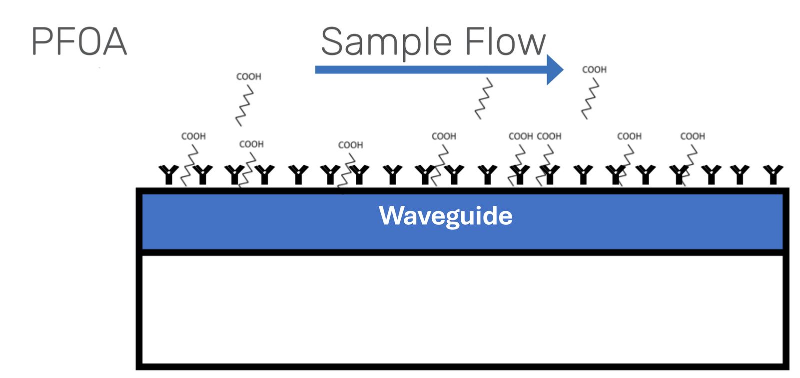


Figure 2: Salvus designed receptors for PFAS detection. Polymer coating 1 was funded and designed by Salvus. Polymer coating 2 was funded and designed as a collaboration between Salvus and Georgia Tech Research Institute.

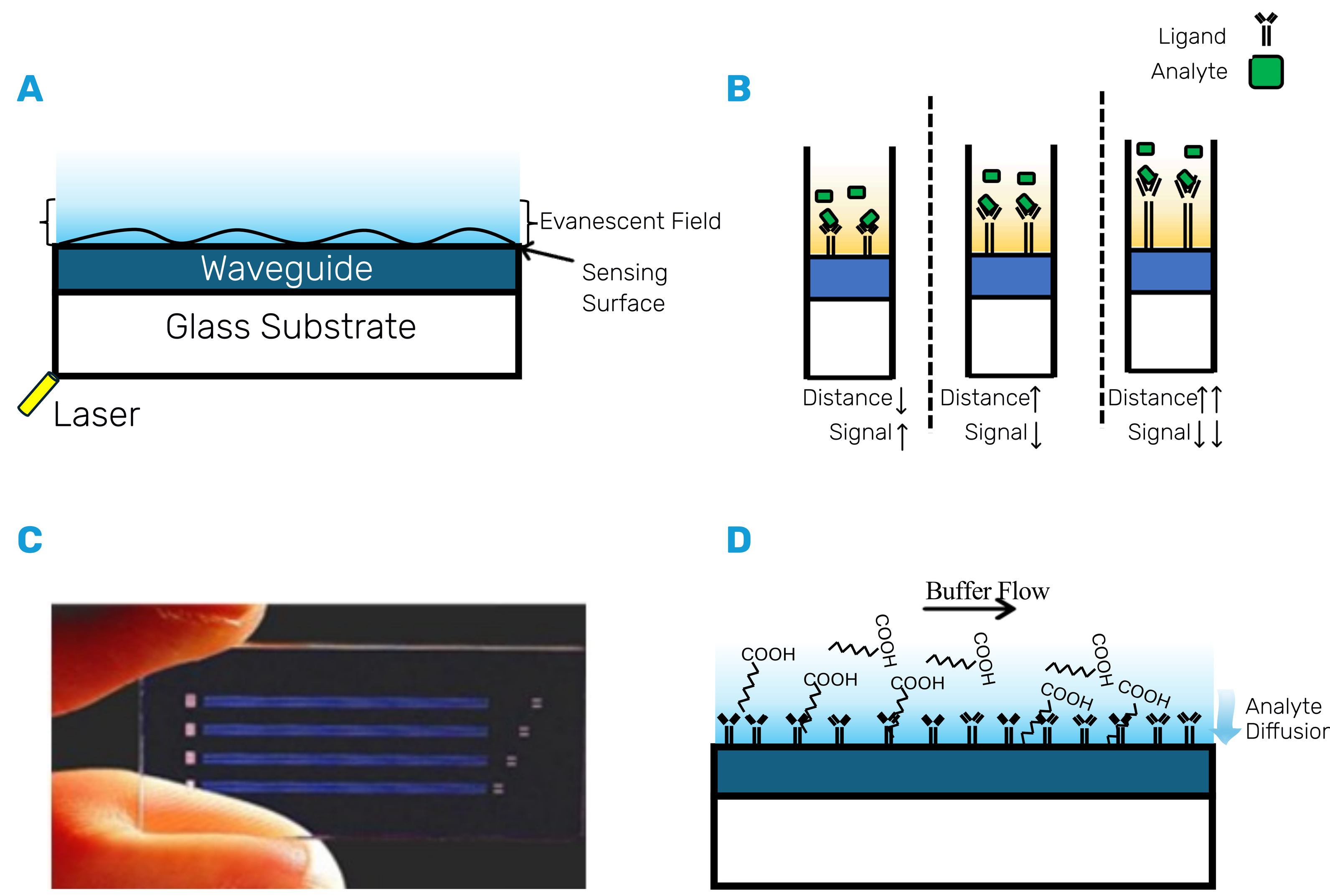


Figure 3: Salvus sensing waveguide. A) Glass substrate with waveguide material coated with a receptor sensing layer for target analyte. B) Relationship between receptor location in evanescent field and signal. C) Layout showing input gratings on the left, four sets of two channels (one is etched and is coated in the target-sensitive receptor layer, and one is a "buried" reference). D) PFAS diffusion and binding to polymer receptor that is specific to perfluorinated compounds.

PFAS RAPID DETECTION DATA

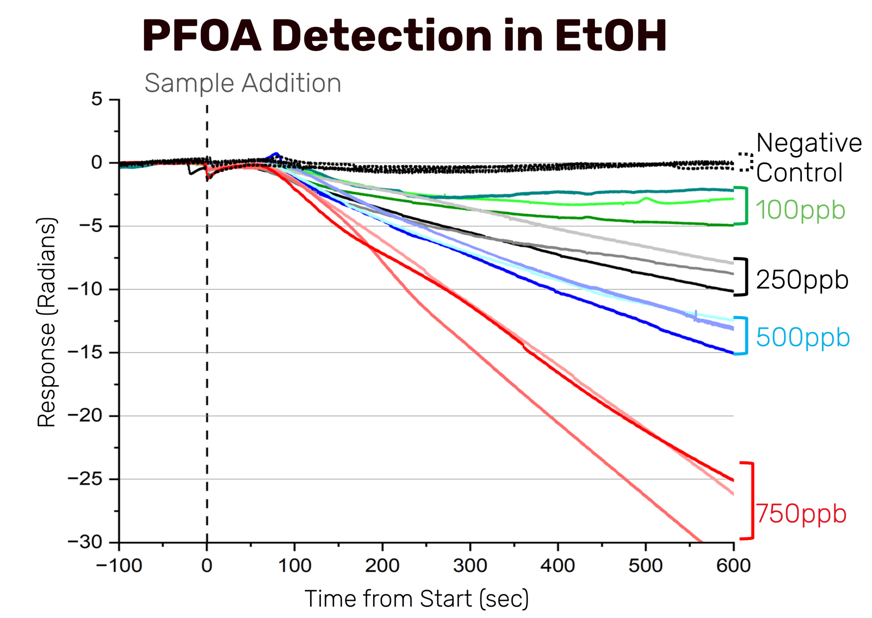


Figure 4. Graph of PFOA detection in ethanol buffer using Salvus analyzer with polymer coating 2. Negative controls at 0 ppb PFOA are shown (black dotted line). Concentrations of PFOA range from 100 ppb to 750 ppb. Detection of PFOA occurs in just 600 seconds from sample addition. Calibration curves enable the user to determine an unknown sample concentration both quantitatively and qualitatively.

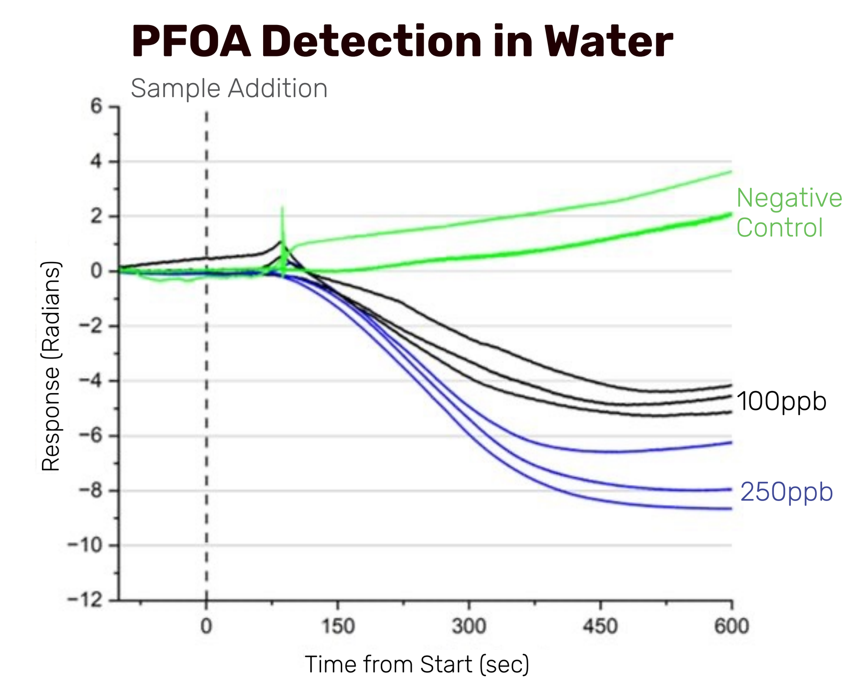
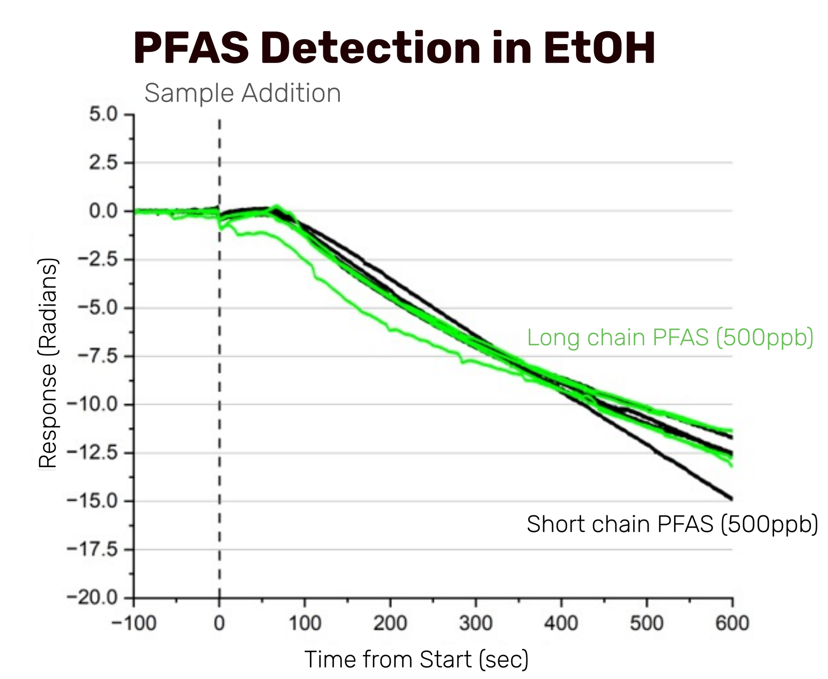


Figure 5. Graph of PFOA detection in a deionized water matrix using polymer coating 1. Negative controls in the absence of PFOA (green) are compared to response curves indicated PFOA detection at 100 ppb (black) and 250 ppb (blue). Initial findings show quantitative detection of PFOA at 100 ppb with qualitative detection of PFOA at 10 ppb (not shown).



Short-chain PFAS Compounds Mix	Long-chain PFAS Compounds Mix
Perfluoro hexanoic acid	PFDA
GenX	PFNA
Nonofluorobutane sulfonic acid	PFOA
PFBA	1H,1H,2H,2H-perfluoro octane sulfonic acid
	Perfluoro heptanoic acid

Figure 6. Graph of various PFAS compound detection in ethanol buffer using Salvus analyzer. A mix of short-chain PFAS compounds containing 6 carbon chains or less is shown (black lines) with a mix of long-chain PFAS containing 7 or more carbons (green lines). PFAS compounds were combined to a final concentration of 500 ppb for both short and long chain. The two mixes show overlapping detection indicating that our coating does not discriminate based on PFAS carbon chain length. This indicates potential of a total PFAS sensor.

FUTURE APPLICATIONS

Site Characterization

Site Remediation

Drinking Water