Detection of Per and Poly-Fluoroalkyl (PFAS) Compounds in Water by Segmented Flow Plasma Degradation Followed by Fluoride Detection

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The detection of per and polyfluoroalkyl substances (PFAS) in aqueous media is a challenging analytical problem, particularly given the very low limits of detection required of the measurement. Liquid chromatography mass spectrometry is currently the most common method of choice (such as in EPA Method 1633) to quantitate and speciate PFAS in aqueous systems. Here, we investigate a different approach based on degradation of the PFAS using a helium plasma, followed by quantitation of the resulting fluoride ion by ion selective electrode detection. A simple segmented flow liquid manifold is used to create alternating series of aqueous sample and helium gas within a quartz capillary. Electrodes placed across the capillary create a dielectric barrier discharge (DBD) within the helium bubbles between each droplet of PFAS containing aqueous solution. The DBD to water interface interaction leads to cleavage of the carbon fluorine bonds of the PFAS molecule through reduction by a solvated electron on the solvent bubble surface, releasing fluorine into solution as fluoride. The movement of the solvent bubble through the capillary will result in stirring of the sample within the capillary, ensuring that the solution-plasma interface is not depleted of analyte to be degraded. This is necessary due to the short lifetime of solvated electrons limiting activity to the plasma to solvent interface. The released fluoride in solution will be transported with the electrolyte into a flow cell through a capillary where a fluoride ion selective electrode will detect the concentration of fluoride in solution. The presented research into the non-targeted detection of fluorine containing compounds has applications in the detection, quantification, and destruction of PFAS in aqueous samples.