A Low Cost Electrochemical Sensor for Ultrasensitive Detection of PFAS

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Per and polyfluoroalkyl substances (PFAS) are a group of stable, chemical compounds, one of the most persistent environmental pollutants still in use in various industrial applications and commercial products worldwide. The strong carbon-fluorine bonds of PFAS make them resistant to physical and metabolic degradation, leading to bioaccumulation and adverse health outcomes in humans and wildlife. Currently, detection of PFAS is carried out in professional laboratories using conventional analytical techniques like HPLC-MS/MS and capillary electrophoresis, which are expensive and not available for large-scale use. Therefore, there is a critical need to develop a low-cost, sensitive method for the detection of PFAS. Herein, we describe the development of a novel, electrochemical detection method for PFAS using the specific interaction between Ag nanoparticles (NPs) and PFAS. The method is based on the use of nano impact electrochemistry that can detect changes in the electrochemical response of single AgNPs as they collide with a charged microelectrode. In the absence of PFAS, AgNPs showed a specific collision pattern at the surface of the electrode due to the oxidation of individual AgNPs at the microelectrode. In the presence of PFAS, a concentration-dependent aggregation of AgNPs was observed causing a proportional decrease in the collision frequency. The high sensitivity of the technique down to single entity levels enabled detection of PFAS below ppt levels, which is far below the maximum permissible limit of PFAS determined by the environmental protection agency (EPA). The underlying mechanism of PFAS interaction with AgNPs was investigated with the help of various physical and chemical characterization techniques such as SEM, XPS, TGA-MS, and FT-IR. Later on, the method was tested for the detection of PFAS in groundwater samples. The proposed detection method has the potential as a rapid tool for the screening of PFAS in ground and surface water.

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