Detecting Forever Chemicals in our waterways with SERS

The global water quality crisis extends across continents, with the United Kingdom facing significant contamination challenges from Per- and Polyfluoroalkyl Substances (PFAS), commonly known as forever chemicals. These synthetic compounds persist in the environment for decades, accumulating in our bodies and waterways. As regulatory agencies establish stricter drinking water standards, the need for rapid, accurate PFAS detection has never been more critical.[1]

Recent research from the University of York reveals that UK rivers contain some of the highest PFAS concentrations ever recorded, with the River Kelvin in Scotland showing average levels of 23,968 nanograms per litre. [2] With at least 45% of US tap water contains one or more types (PFAS). [3]

The Growing Threat of PFAS Contamination

PFAS represent a family of over 12,000 synthetic chemicals used since the 1940s in products ranging from non-stick cookware to firefighting foam. In the UK, analysis reveals that 35% and 37% of water courses tested in England and Wales contain medium or high-risk levels of PFOS (Perfluorooctanesulfonic acid) and PFOA (Perfluorooctanoic Acid) respectively.[4] The maximum concentration found in Glasgow reached 78,464.2 ng/L, marking the second highest level of Trifluoroacetic acid (TFA) , which is an ultra-short-chain PFAS contamination ever recorded in surface water globally. [2] Research from the University of Birmingham detected PFOA and PFOS in over 99% of bottled water samples from 15 countries, including the UK [5]

The Environmental Protection Agency (EPA) has established maximum contaminant levels at 4 parts per trillion for PFOA and PFOS in the United States.[6] Current data confirms 172 million Americans live in communities where drinking water has tested positive for PFAS.[7] Research links PFAS exposure to serious health conditions including cancer, liver damage, thyroid disease, and developmental issues in children. Traditional detection methods using liquid chromatography-mass spectrometry require weeks of processing time, specialized laboratory equipment, and costs reaching hundreds of dollars per sample. These limitations prevent rapid response to contamination events and restrict regular monitoring in vulnerable communities.

How SERS Technology Enables Fast PFAS Detection

Surface-Enhanced Raman Spectroscopy (SERS) offers a transformative approach to water quality monitoring. This optical technique amplifies molecular signals through plasmonic enhancement on metallic nanostructures, typically gold or silver substrates. SERS can identify and quantify various PFAS in water with limits of detection reaching 1 part per trillion.[8] The technique works by detecting characteristic spectral peaks unique to PFAS molecules, including the CF2 symmetric stretching mode around 725 cm^{-1} and CF stretching modes near 1300-1350 cm^{-1}.[9] SERS methods can detect PFAS levels as low as 20 femtograms per liter in less than 30 seconds, representing detection speeds hundreds of times faster than conventional laboratory methods.[10] Recent UK research demonstrates that silver nanowire-based SERS substrates enable quantitative detection of multiple PFAS species at

concentrations as low as 10^{-8} M with excellent reusability.[11]Unlike chromatography-based techniques, SERS requires minimal sample preparation and provides immediate results suitable for field deployment and on-site testing scenarios.

Wave Lumina is developing a portable PFAS screening platform capable of rapid, same-day detection of PFAS-class surfactants. This technology is designed to streamline environmental screening workflows, enabling professionals to efficiently triage site samples while reducing both time and cost relative to conventional laboratory analyses.[12]

Why choose Nikalyte SERS for PFAS Detection?

Nikalyte SERS substrates that have been tested for environmental monitoring applications. Our gold and silver paper-based SERS substrates deliver laboratory-grade sensitivity in a portable, user-friendly format designed for field deployment. These substrates ensure reproducible results and enhancement Raman spectra up to 1000x compared to traditional colloidal SERS, with high sensitivity in the ppm to ppb range. [13] Water utilities, environmental consultants, and regulatory agencies can now conduct on-site PFAS screening with accuracy comparable to centralized laboratories. The paper substrate format eliminates complex sample handling procedures while maintaining stability during storage and transport. This accessibility democratizes advanced analytical capabilities, enabling more frequent monitoring in communities disproportionately affected by PFAS contamination across the UK and globally.

Conclusion

The convergence of stringent regulatory standards and advanced detection technologies creates new possibilities for water safety management. SERS-based monitoring enables proactive contamination response rather than reactive remediation after weeks of laboratory analysis delays. As communities nationwide work to comply with EPA drinking water standards by 2029, rapid detection tools become essential infrastructure.[6] SERS technology supports not only compliance monitoring but also source identification, treatment verification, and public health protection. Investment in advanced detection capabilities today prevents the long-term health consequences and remediation costs associated with prolonged PFAS exposure.

Discover how Nikalyte SERS substrates can advance your water testing research. Shop SERS substrates now!

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