# Scientists develop luminescent sensor to detect 'forever chemicals' in water

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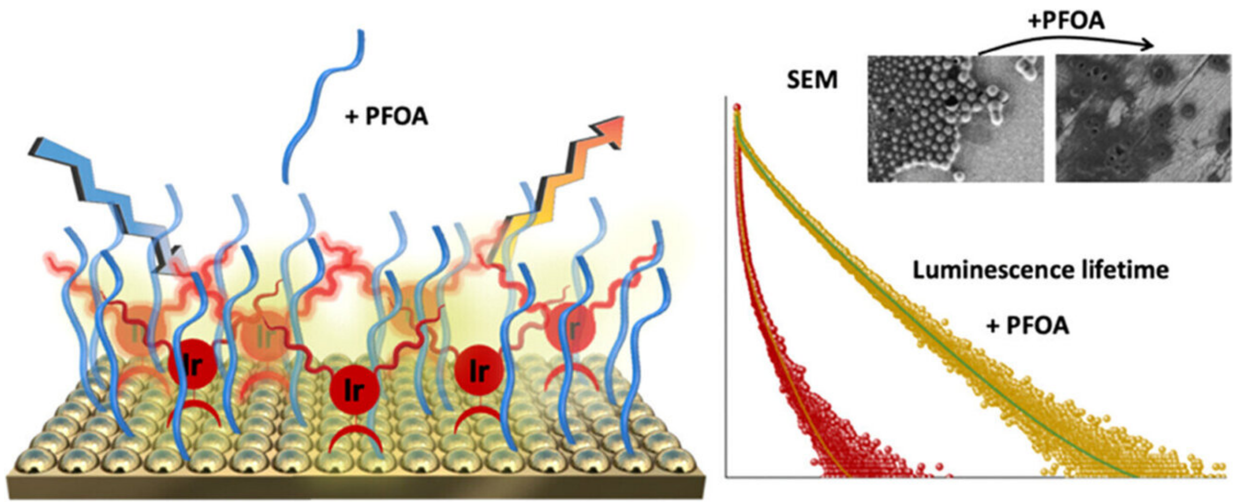


Graphical Abstract. Luminescence lifetimes are an attractive analytical method for detection due to its high sensitivity and stability. Iridium probes exhibit luminescence with long excited-state lifetimes, which are sensitive to the local environment. Perfluorooctanoic acid (PFOA) is listed as a chemical of deep concern regarding its toxicity and is classified as a “forever chemical.” In addition to strict limits on the presence of PFOA in drinking water, environmental contamination from industrial effluent or chemical spills requires rapid, simple, accurate, and cost-effective analysis in order to aid containment. Herein, we report the fabrication and function of a novel and facile luminescence sensor for PFOA based on iridium modified on gold surfaces. These surfaces were modified with lipophilic iridium complexes bearing alkyl chains, namely, IrC6 and IrC12, and Zonyl-FSA surfactant. Upon addition of PFOA, the modified surfaces IrC6-FSA@Au and IrC12-FSA @Au show the largest change in the red luminescence signal with changes in the luminescence lifetime that allow monitoring of PFOA concentrations in aqueous solutions. The platform was tested for the measurement of PFOA in aqueous samples spiked with known concentrations of PFOA and demonstrated the capacity to determine PFOA at concentrations >100 μg/L (240 nM). Credit: *Analytical Chemistry* (2024). DOI: 10.1021/acs.analchem.3c04289

Researchers have created a new way to detect 'forever chemical' pollution in water, via a luminescent sensor.

Scientists in Chemistry and Environmental Science at the University of Birmingham in collaboration with scientists from the Bundesanstalt für Materialforschung und -prüfung (BAM), Germany's Federal Institute for Materials Research and Testing, have developed a new approach for detecting pollution from 'forever chemicals' in water through luminescence.

PFAS or 'forever chemicals' are manufactured fluorine chemicals that are used widely in different industries—from food packaging to semiconductor production and car tires. They are non-degradable and accumulate in the environment. Concerns regarding the toxic pollution they cause, particularly in water, have been rising in recent years.

Stuart Harrad, Professor of Environmental Chemistry at the University of Birmingham, who—with colleague Professor Zoe Pikramenou, Professor of Inorganic Chemistry and Photophysics—co-led the design of a new sensor, said, "Being able to identify 'forever chemicals' in drinking water, or in the environment from industrial spills is crucial for our own health and the health of our planet."

"Current methods for measurement of these contaminants are difficult, time-consuming, and expensive. There is a clear and pressing need for a simple, rapid, cost-effective method for measuring PFAS in water samples onsite to aid containment and remediation, especially at (ultra)trace concentrations. But until now, it had proved incredibly difficult to do that."

The researchers, who have published their findings in *Analytical Chemistry*, have created a prototype model which detects the 'forever chemical' perfluorooctanoic acid (PFOA). The approach uses luminescent metal complexes attached to a sensor surface. If the device is dipped in contaminated water, it detects PFOA by changes in the luminescence signal given off by the metals.

Professor Pikramenou commented, "The sensor works by using a small gold chip grafted with iridium metal complexes. UV light is then used to excite the iridium, which gives off red light. When the gold chip is immersed in a sample polluted with the 'forever chemical,' a change of the signal in the luminescence lifetime of the metal is observed to allow the presence of the 'forever chemical' at different concentrations to be detected."

"So far, the sensor has been able to detect 220 micrograms of PFAS per liter of water, which works for industrial wastewater, but for drinking water, we would need the approach to be much more sensitive and be able to detect nanogram levels of PFAS."

The team has collaborated with surface and sensor scientists BAM in Berlin for assay development and dedicated analytics at the nanoscale. Dan Hodoroaba, head of BAM's Surface and Thin Film Analysis Division, emphasized the importance of chip characterization, "Advanced imaging surface analyses are essential for the development of dedicated chemical nanostructures on customized sensor chips to ensure optimal performance."

Knut Rurack, who leads the Chemical and Optical Sensing Division at

BAM, added, "Now that we have a prototype sensor chip, we intend to refine and integrate it to make it portable and more sensitive so it can be used on the site of spills and to determine the presence of these chemicals in drinking water."

Professor Pikramenou concluded "PFAS are used in industrial settings due to their useful properties for example in stain-proofing fabrics. But if not disposed of safely these chemicals pose a real danger to aquatic life, our health, and the broader environment. This prototype is a big step forward in bringing an effective, quick, and accurate way to detect this pollution, helping to protect our natural world and potentially keep our drinking water clean."

**More information:** Kun Zhang et al, Luminescence Lifetime-Based Sensing Platform Based on Cyclometalated Iridium(III) Complexes for the Detection of Perfluorooctanoic Acid in Aqueous Samples, *Analytical Chemistry* (2024). DOI: 10.1021/acs.analchem.3c04289

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