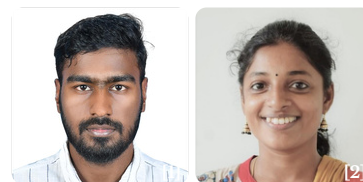


Sensing the Unseen: An Indigenous Sensor for Aqueous PFOA Measurement

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Introduction

Per- and polyfluoroalkyl substances (PFAS) are a group of man-made organo-fluorine chemicals that have been termed "forever chemicals" due to their exceptional chemical stability. Among the reported PFAS compounds, perfluorooctanoic acid (PFOA) is notable for its global presence due to widespread applications and high environmental persistence. PFOA, with a half-life of 40 years, bioaccumulates in living organisms and poses significant health risks, including immunotoxicity and carcinogenicity. In addition, PFOA often serves as a stable degradation product of various precursor perfluorinated compounds. Consequently, developing analytical methods for the determination of PFOA in water bodies is essential toward protecting water resources and public health.

The most common analytical methods used to determine PFOA compounds include chromatographic techniques coupled with mass spectrometry. Although chromatography methods provide accurate and sensitive measurements, they often require expensive instrumentation, making them unsuitable for in situ or real-time monitoring applications. Moreover, traditional chromatography techniques are limited by their complex sample preparation and lack of field portability. Thus, to overcome the limitations of chromatography techniques, several other methods have been developed for PFOA detection. Among the reported techniques, the most notable is fluorescent detection. The techniques involve interaction between target PFOA compound and fluorescence sensor, and subsequent measurement of corresponding fluorescence intensity.

Turning Molecular Interactions into Information (Patent no: 571206)

Our research group has developed a Cu-based fluorescence sensor for the detection of PFOA in aqueous solution. The principle of fluorescence detection of PFOA involves the measurement of fluorescence emission of compounds in response to light excitation. It should be noted that in the presence of PFOA, the fluorescence emission intensity may increase or decrease, as shown in Figure 1. Thus, a linear relationship between change in fluorescence intensity and varying concentrations of PFOA is recorded to establish a standard detection method for PFOA in the aqueous environment.

The sensor exhibited a measurable fluorescence response upon interaction with PFOA, enabling detection over a defined concentration range of 1.2 to 24 μM . Thereby establishing a strong emphasis for further optimization, sensitivity enhancement, and real-sample validation.

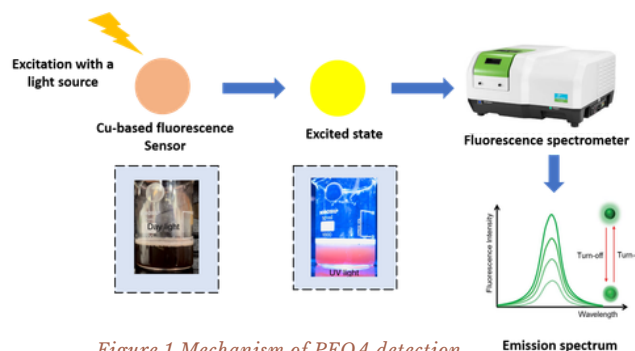


Figure 1 Mechanism of PFOA detection

The outcome of the study includes:

- **Widespread Real-Time Surveillance:** Facilitating continuous, on-site PFOA monitoring in diverse water bodies, overcoming the current bottleneck of centralized lab analysis. This empowers immediate decision-making for public health and environmental protection.
- **Enhanced Regulatory Compliance:** Providing accessible tools for regulatory bodies to enforce PFOA limits more effectively and broadly, supporting tighter control over this persistent pollutant.
- **Economic Accessibility:** Significantly reducing the financial and logistical barriers associated with PFOA testing, making advanced monitoring capabilities accessible to a wider range of stakeholders, including municipalities and industries.
- **Improved Public Health Outcomes:** Enabling rapid identification of contamination sources, allowing for quicker intervention to protect communities from PFOA exposure.

Potential Applications

The developed Cu-based fluorescence sensor for PFOA detection has significant potential for real-world environmental and industrial applications. Its low cost, rapid response, and minimal instrumentation requirements make it highly suitable for on-site monitoring of PFAS contamination in surface water, groundwater, and drinking water sources. The sensor can be integrated into portable fluorescence devices for real-time surveillance at industrial discharge points, landfills, wastewater treatment plants, and contaminated sites, enabling early detection and risk mitigation.

From an industrial perspective, this sensing platform can be employed for routine compliance monitoring in sectors such as fluoropolymer manufacturing, textile finishing, firefighting foam production, and electroplating industries, where PFAS usage and discharge are prevalent.

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