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Laser-Induced Fluorescence Spectroscopy based sensors for Environmental Monitoring: Applications in Water and Air Quality Assessment

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Environmental contamination by heavy metals in water and Particulate matter (PM) in air poses severe risk to ecosystems and human health. Heavy Metals such as Arsenic (As), Lead (Pb) and Mercury (Hg) in drinking water are linked to cancers, neurological damage, and developmental disorders, while airborne Particulate Matter especially, $PM_{2.5}$ and PM_{10} contribute to respiratory and cardiovascular diseases. Laser-Induced Fluorescence (LIF) offers a sensitive, portable, and rapid choice for pollutant monitoring, making it highly relevant for environmental quality assessment. In this study we had developed LIF-based sensors which have enabled trace-level detection of As, Pb, and Hg in water and achieved WHO detection limits. Also in air quality monitoring, LIF has been employed for rapid characterization of particulate matter ($PM_{2.5}$ and PM_{10}). By detecting intrinsic fluorescence of organic compounds, LIF provides chemical fingerprints that support source identification and real-time pollution assessment. Overall, LIF demonstrates versatility as a cost-effective tool for environmental monitoring, combining sensitivity, selectivity, and portability to address critical challenges in both water and air quality assessment.

Keywords: Laser-Induced Fluorescence, Heavy Metal sensing, Atmospheric Particulate Matter, Environmental monitoring

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