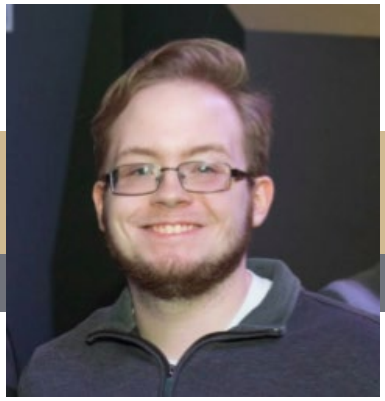
ANALYTICAL SEMINAR

Laser Induced Breakdown Spectroscopy (LIBS) for the Detection and Quantitation of Light Rare Earth Elements

Seth Koloski

Graduate Student
Purdue University



Light molecular weight elements in the lanthanide series, also known as light rare earth elements, have a wide array of uses in daily life. Due to their unique magnetic, luminescent, and conductive properties, they have been incorporated into many modern electronics, renewable energy sources, and military defense applications. Contrary to what their name implies, these rare earth elements are found throughout the world, but the challenge lies in locating economically viable concentrations. Common analytical techniques for elemental detection such as ICP-MS and ICP-OES require extensive sample preparation and cannot be done in the field. These factors lead to slow processing of samples creating a bottleneck in decision making for potential mining operations to harvest rare earth elements. Laser-induced breakdown spectroscopy provides an avenue for which these elements can be rapidly detected and quantified with little sample preparation. By applying a pulsed laser to a sample, some of the surface is ablated and a plasma is formed. As this plasma cools, characteristic elemental emissions are captured and combined into one spectrum. These emissions can be used, in tandem with calibration, to quantify the presence of light rare earth elements.

Tuesday, November 25, 2025 3:30 pm WTHR 172

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Fluorescent Gold Nanocluster Sensor Arrays with Machine Learning for Multi-Target Analysis

Philip Duvall

Graduate Student
Purdue University

Gold nanocluster (AuNC)-based fluorescent sensor arrays offer a robust and tunable platform for analyzing multiple targets simultaneously due to their high sensitivity, customizable surface chemistry, and compatibility with biological systems. These arrays create multidimensional signal patterns by using the unique fluorescence responses from controlled interactions between the targets and the AuNCs. By combining the response profiles with machine learning, single and multiple analyte mixtures can be accurately classified and measured, even in complex physiological settings. This approach addresses the limitations of traditional selective probes, enabling high-throughput, scalable, and cross-reactive sensing for tasks such as monitoring phosphate levels in biological systems and identifying heavy metal ions in environmental matrices.

Tuesday, November 25, 2025 | 3:30 pm | WTHR 172

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Recent Advances in Pathogen Detection via Molecularly Imprinted Polymers

David Toba

Graduate Student
Purdue University

Pathogen quantification has traditionally relied on methods that involve gene amplification reactions, immunological assays, or culture-based tests. Although these approaches may offer high sensitivity and specificity, they often lack portability, affordability, and ease of use. To address these limitations, molecularly imprinted polymers (MIPs) have emerged as durable and cost-effective sensors that can be readily applied in point-of-care testing. Their fabrication involves polymerizing functional monomers around a target, generating recognition sites that mimic ligand-receptor binding. Recent advances will be highlighted with the introduction of dual-MIP paper-based sensors providing on-site virus detection, as well as ingestible MIP-integrated capsules enabling bacteria sampling throughout the gastrointestinal tract. The versatility, chemical stability, and selective binding of molecularly imprinted polymers position them as an accessible alternative to conventional pathogen-detection technologies.

Tuesday, November 25, 2025 | 3:30 pm | WTHR 172

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