

ANALYTICAL SEMINAR

How Chemometrics Paired with FTIR has Revolutionized the Identification of Chemical Forensic Evidence

Ashley Galligan

Graduate Student, Purdue University



Bio: Ashley earned her B.S. in Chemistry with a minor in Explosives Engineering from Colorado School of Mines in Spring 2023. She joined the Kenttämää group in Fall 2023 where her research focuses on discovering diagnostic gas-phase ion-molecule reactions to identify and analyze complex mixtures using mass spectrometry.

Abstract: Accuracy and efficiency are of the utmost importance when analyzing forensic evidence. To obtain a conviction, the results presented need to be portrayed beyond a reasonable doubt. For the analysis of illicit drugs and high energetic materials, Fourier-transform infrared spectroscopy (FTIR) is one of the key techniques, providing a plethora of data and insights into bond vibrations and functional groups within a compound. One caveat to this, however, is the high dimensionality of the data. By pairing FTIR with chemometrics, the data complexity can be effectively reduced, streamlining the analysis processes, which can facilitate the classification of compounds into unique groups. This presentation will focus on discussing two of the prominent multivariate analysis methods and demonstrate how their integration with FTIR has revolutionized the identification of illicit drugs and high energetic material. In particular, this pairing allows for the distinguishment of small variants (cutting agents) in seized drugs, and even has the potential to develop trafficking networks in a specific area. In a similar manner, this method is a way to track small differences in explosive material to discover its manufacturing process.



Tuesday, September 3rd, 2024



3:30 pm



WTHR 172

ANALYTICAL SEMINAR

Charting the Unexplored Skies of Stochastic Optical Reconstruction Microscopy (STORM) with Bubble-STORM and Quantum-STORM

Laura Lukov

Graduate Student, Purdue University



Bio: Laura is a 2nd year PhD student in Professor Jesse Zhang's Lab, where she works with biochemical applications of real-time precision opto-control (RPOC) technology. One of her current projects involves tracking intracellular calcium flux after ER perturbation. Prior to coming to Purdue, she graduated from BYU-Hawaii with a B.S. in Biochemistry, minoring in Mathematics and History and TESOL.

Abstract: In classical fluorescence microscopy, the Abbe limit ($d=0.50\lambda/NA$) requires separation greater than ~250 nm between point sources for effective spatial resolution. Fluorescence Imaging with One Nanometer Accuracy (FIONA) surpasses this diffraction limit by determining point spread function centroids rather than entire areas of detected intensity. However, FIONA only resolves clusters of ≤ 5 fluorophores, due to the inherent inability of translating localization accuracy of crowded light emitters into imaging resolution. Stochastic Optical Reconstruction Microscopy (STORM) enables resolution of many more point sources via photoswitchable fluorophore centroid analysis and image accumulation over time. In 2021, Bubble-STORM emerged as a label-free variation for hydrogen evolution reaction mapping, where surface plasmon resonance microscopy (SPRM) is coupled with a bubble localization algorithm. Quantum-STORM developed into a 3D dual-color technique with quantum dots where photoswitching enhancers and multiple lasers are not needed, in contrast with traditional STORM setups. The scope of STORM continues to broaden, promising potential for use in fields as diverse as brine desalination to ultrasound imaging in the near future.



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ANALYTICAL SEMINAR

Real Time Visualization of Endogenous Hydrogen Peroxide in Spheroids by Electrochemiluminescence

Vanshika Gupta

Graduate Student, Purdue University



Bio: Vanshika Gupta is a fourth-year graduate student in the Jeffrey Dick lab. She received her B.S. degree in Biochemistry from San Jose State University in California where she worked with Dr. Madalyn Radlauer to design single chain polymeric nanoparticles for greenhouse gas to fuel conversion. Post-graduation, she worked as an Amgen scholar with Dr. Netz Arroyo at Johns Hopkins University investigating the use of osmium-based complexes for electrochemical aptamer-based sensors before starting her PhD at University of North Carolina at Chapel Hill in the Jeffrey Dick group in Fall 2021. She moved with the Dick lab to Purdue the following year. During her time at Purdue, she has received the NSF GRFP fellowship and is now working towards finishing her dissertation work developing new measurement tools to better understand real-time processes in tumor models and single cells.

Abstract: Three-dimensional cells known as “spheroids” have recently gained attention for drug screening and personalized medicine applications. These models are superior to their two-dimensional monolayer counterparts in that they can mimic the in vivo cellular responses, metabolic activity, and cell-to-cell interactions found in tumors and healthy tissue. Most 3D spheroids have three main anatomical layers called the proliferation zone, the quiescent zone, and the necrotic core. In the first two layers, cells majorly use oxidative phosphorylation to convert glucose into ATP for energy while the necrotic core prefers glycolytic metabolism as it generates ATP faster. This preferential choice made by the core results in the conversion of glucose to lactate which in turn acidifies the microenvironment inside the spheroid. The change in the microenvironment allows cells to become resistant to many drugs making it one of the most important structures to understand. While diverse microscopic techniques such as confocal microscopy and fluorescence lifetime imaging have been employed to envision these layers, the core has only been visualized in mature tumors and the exact timeline for its growth remains unknown. In our study, we use a luminol and hydrogen peroxide system to electrochemically generate light at the spheroid|electrode interface to study the endogenous production of hydrogen peroxide in the core as a function of drug induced stress, and as a function of spheroid maturation. We show that the core can be visualized using electrochemiluminescence as early as the third day after spheroid seeding.



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