FURMAN

Chemistry Department
2021 Summer Research Program

Mac Gilliland Research Group

Research in the Gilliland lab is centered on using mass spectrometry to solve clinical, biological, and chemical problems. The three current areas of research are: (1) Chemical modification of paper substrates for detection and quantification of antiretrovirals in dried blood spots; (2) Development of an assay to detect 3-bromotyrosine and 3-nitrotyrosine as diagnostic biomarkers for eosinophilic esophagitis; and (3) Using microdroplet chemistry coupled with mass spectrometry to study polymer synthesis.

(1) Microsampling is the collection of small volumes of blood (< 50 μL) for quantitative determination of drug concentrations or target biomolecules, which offers a low-volume alternative to traditional blood sampling techniques. Microsampling is an ideal tool for drug development, especially for pharmacokinetic studies in animals or pediatric populations, where only a small volume of blood may be collected. Dried blood spots (DBS) have emerged as a primary microsampling technique due to their ease of sample collection and low cost. The goal of this project will be to use antiretrovirals (ARVs) used to treat HIV as model compounds to detect drugs in DBS using paper spray mass spectrometry (PS-MS). PS-MS enables extraction and ionization directly from DBS, and paper spray from DBS has been demonstrated for other drugs in DBS but has yet to be applied to ARVs.[1,2] We will explore methods for the quantification of ARVs as well as chemical and physical modifications we can make to paper substrates to improve detection.

(2) Eosinophilic esophagitis (EoE) is a chronic allergic disease characterized by high infiltration of eosinophils (a type of white blood cells) into the epithelium of the esophagus and is estimated to affect 56 out of every 100,000 children in the United States.[3–5] Endoscopy with biopsy is currently the only way to diagnose EoE, but this procedure is invasive and expensive. A non-invasive alternative to this procedure would be greatly beneficial. Urinary levels of 3-bromotyrosine (3-BT) and 3-nitrotyrosine (3-NT) have been shown to correlate with disease activity in patients with EoE.[6] Liquid chromatography (LC) is an ideal tool for this type of analysis. Therefore, the second goal of the Gilliland lab will be to develop a sample preparation protocol and LC method to monitor 3-BT and 3-NT in urine.

(3) Many organic reactions have been shown to be accelerated at factors of up to 10^6 in microdroplets as compared to bulk solution.[7] Combined with mass spectrometry, these reactions can be studied in real time. Polymerization reactions are complex and can lead to branching and side products, and their mechanisms can be difficult to study. The primary focus of this project is to study the synthesis of

polypyrrole and polyaniline using microdroplet chemistry coupled with mass spectrometry. Polymerization reactions have yet to be studied by this technique, so a secondary focus is to investigate how polymerization reactions behave in microdroplets.

References

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