

## MATERIALS ENGINEERING SEMINAR

### “Smart Capsule with Stimuli-Responsive Polymers for Targeted Sampling from the Gastrointestinal Tract”

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#### ABSTRACT

The gastrointestinal (GI) tract and its diverse microbial community play a significant role in overall health, impacting various aspects such as metabolism, physiology, nutrition, and immune function. Disruptions in the gut microbiota have been associated with metabolic diseases, colorectal cancer, diabetes, obesity, inflammatory bowel disease, Alzheimer's disease, and depression. Despite recognizing the importance of the gut microbiota, the interrelationship between microbiota, diet, and disease prevention remains unclear. Current techniques for monitoring the microbiome often rely on fecal samples or invasive endoscopic procedures, limiting the understanding of spatial variations in the gut microbiota and posing invasiveness challenges. To address these limitations, this dissertation focuses on the design and development of an electronic-free smart capsule platform capable of targeted sampling of GI fluid within specific regions of the GI tract. The capsule can be retrieved for subsequent bacterial culture and sequencing analysis. The capsule design is based on stimuli-responsive polymers and superabsorbent hydrogels, chosen for their proven safety, compatibility, and scalability. By leveraging the pH variation across the GI tract, the pH-sensitive polymeric coatings dissolve at the desired region, activating the sampling process. The superabsorbent hydrogel inside the capsule collects the sampled GI fluid and facilitates capsule closure upon completion of sampling. Systematic studies were conducted to identify suitable pH-responsive polymer coatings, superabsorbent hydrogels, and processing conditions that effectively operated within the physiological conditions of the GI tract. The technology's effectiveness and safety were validated through rigorous *in vitro* and *in vivo* studies using pig models. These studies demonstrated the potential of the technology for targeted sampling of GI fluid in both small and large intestinal regions, enabling subsequent bacterial culture and gene sequencing analysis. Additionally, the capsule design was enhanced with the integration of a metal tracer, enabling traceability throughout the GI tract using X-ray imaging and portable metal detectors for ambulatory screening. This technology holds promise as a non-invasive tool for studying real-time metabolic and molecular interactions among the host, diet, and microbiota in challenging-to-access GI regions. Its application in clinical studies can provide new insights into diet-host-microbiome interactions and contribute to addressing the burden faced by patients and their families dealing with GI-related diseases.

**Date: Monday, July 31, 2023**

**Time: 3:00 P.M.**

**Place: BIRCK 1001 or via this link:**

<https://purdue-edu.zoom.us/j/9763106414?pwd=dVFhcjcxZEt1aExRNFBwalZwNkRoZz09>