

**MATERIALS ENGINEERING
SEMINAR**

**“Electrical Monitoring of Degradation and Dissolution Kinetics of Bioresponsive Polymers for
In Situ Assessment of Microbial Activity”**

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Purdue MSE PhD Dissertation
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ABSTRACT

Microbes play key roles in processes that shape the world around us having direct impact in crop production, food safety, digestion, and overall health. Developing tools to monitor their activity in-situ is the key towards better understanding the true impact of microbial activity in these processes and, eventually, harnessing their potential. Many conventional techniques for microbial activity assessment require sample collection, expensive benchtop equipment, skilled technicians, and destructive sample processing which makes their adaptation for in-situ monitoring cumbersome. The need for technologies for in-situ monitoring has led to the development of many sensor designs, capable of detecting single strains of bacteria to low limits of detection (LOD). These designs, however, are limited to their complex manufacturing procedures, cost, and delicacy which makes them difficult to implement outside of a laboratory setting into harsh environments.

In the last 25 years, impedimetric sensing methods have been used as powerful analytical tools to characterize the degradation and dissolution of polymers. Known for their robustness, these techniques were mainly used for characterizing polymer's properties as corrosion-protective layers on metals. At the time, some researchers pondered on the potential use of this technique for biosensing applications. In this thesis, the ability of monitoring microbial activity in-situ was explored by integrating different bioresponsive polymers with low-cost electronic impedimetric platforms and assessing their degradation kinetics in response to microbes.

This novel use of impedimetric sensing methods and approach towards microbial activity sensing was systematically studied in different areas including agriculture, food packaging, and healthcare. Microbes, the good, the bad, and the ugly, were studied within their ecosystems to demonstrate the ability of using the described systems in in-situ monitoring. In agriculture, polymer degradation was successfully correlated to the concentration of decomposing bacteria directly in soil. In food packaging, spoilage of chicken samples was successfully detected within their package through a non-reversible system. In healthcare, a wireless and electronic-free wound monitoring system capable of detecting early onset of infection while delivering therapeutics without the need of external actuation was achieved. Further developments of this technology will present the key towards monitoring microbial activity in-situ in a large scale, providing solutions to humanity's toughest upcoming challenges including food production, food safety, and healthcare.

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