Applications of 3D Printing in Biofilm Engineering and High-Throughput Diagnostics Development

Doctoral Defense

Isaak Thornton

Montana State University
Department of Mechanical and Industrial Engineering
Bozeman, Montana

Friday, November 15
12:10 PM MST
Roberts Hall, Room 321

I will present two applications of 3D printing: synthetic biofilms and high-throughput diagnostic testing.

Biofilms are communities of microorganisms that adhere to surfaces. These communities play vital roles in ecological processes like nutrient cycling and hold promise for sustainable applications like bioremediation. They also present challenges in areas like healthcare and infrastructure, where biofilm-associated infections and microbially induced corrosion are costly and difficult to control. Biofilms form complex structures containing heterogenous microenvironments, which give rise to properties like antimicrobial tolerance and metabolic diversity. To better understand these structure-function relationships, I introduce a light-based 3D printing approach to create synthetic biofilm models by embedding bacteria in photopolymerized hydrogels, allowing precise manipulation of biofilm composition and architecture. This method enables systematic studies of structure-function relationships, laying a foundation for design of biofilms with directed characteristics.

As evidenced by the recent COVID-19 pandemic, rapid and scalable diagnostic testing is essential for effective disease surveillance and pandemic response. Traditional diagnostic methods, while sensitive and accurate, often require centralized facilities and are limited in throughput. Here, I will discuss the use of 3D printing to develop a high-throughput diagnostic platform designed for viral detection. By integrating isothermal nucleic acid amplification with automated fluorescence detection, this system can process more than 2,000 samples per hour, providing a scalable and accessible solution for fast, decentralized testing. Together, these projects illustrate how advanced manufacturing technologies like 3D printing can catalyze innovation in both fundamental research and technology development.

Advisor: James Wilking