Project Title: Rapid 3D Prototyping of Hierarchically Porous Multilayered Membranes for Enhanced Oil-Water Filtration

Abstract:
This study introduces a novel approach to 3D printing multilayered hierarchical porous membranes (MHMs) using Direct Ink Writing (DIW) technology, representing a significant advancement over traditional flat sheet single-layered membranes. The 3D-printed MHMs achieved an impressive oil/water emulsion rejection rate of 99.02% and demonstrated exceptional reusability, maintaining a flux recovery ratio of 99.48% after 150 minutes of continuous filtration. Fabricated through a layer-by-layer printing process with varying concentrations of pore-forming agents, these thin (~250 μm) MHMs mimic the hierarchical pore structure and filtration capabilities of natural soil systems. Despite their comparable thickness to commercial membranes, the 3D-printed MHMs exhibit superior hierarchical porous architecture and mechanical integrity. The simplicity, versatility, and cost-effectiveness of this manufacturing method make it highly suitable for on-demand membrane production across various applications. This study highlights the potential for scalable 3D printing of customized multilayer membranes with tailored porosity and high-performance filtration properties, offering a new pathway for advanced membrane design and production in water treatment and other separation processes.