MSc thesis project

Towards the next generation of 3D printers for printing micro/nanoscale features

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Overview

3D printing involves a layer-by-layer building of a wide-range of materials, including polymers, ceramics or metals.[1,2] This technology has been recently applied to advanced porous membrane manufacturing for making microscale pores.[3-5] (**Figure 1 left**). However, it has some important limitations such as printing resolution, high production cost, limited material type, and a slow fabrication procedure. As such, it is still a challenge to 3D print membranes with nanoscale pores.

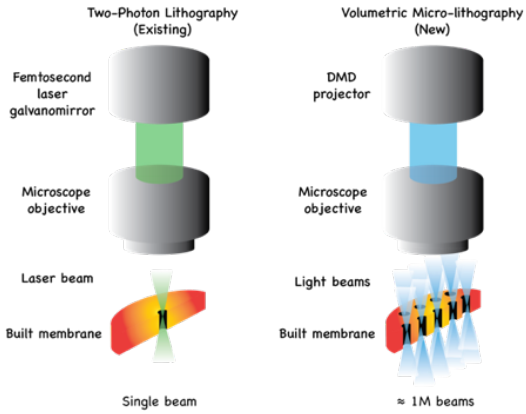

Figure 1. Existing (left) and our novel 3D printing technique.

Why 3D printing membranes?

In the past 40 years membrane separation technology has advanced rapidly. Phase inversion (non-solvent induced phase separation (NIPS)) is the current fabrication method of porous polymeric membranes (**Figure 2**).[6,7] Although membrane separation is considered as a green process, membrane fabrication cannot be considered as a sustainable process. This is mainly because hazardous solvents are required.[8,9] Apart from wasting huge amounts of solvents and creating large volumes of wastewater, with these methods, it is difficult to control the precision and the uniformity of the pores.

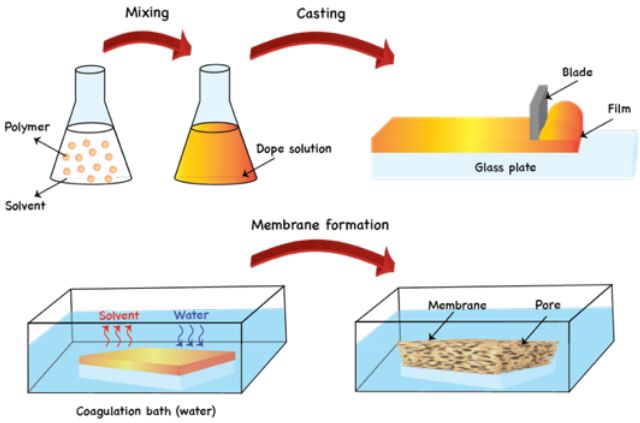

Figure 2. NIPS technique for making porous membrane.

Objectives

In this project, you study a novel 3D printing method for directly 3D printing membranes with microscale pore size. The novelty is based on a volumetric lithography approach where an object is created by a million light beams simultaneously (**Figure 1 right**). This technique is beneficial for serial fabrication of products with micro/nanoscale features which is ca. 1000x faster and less expensive compared to the current state-of-the-art techniques.

Research plan

You will study 3D printing of membranes using various polymeric materials based on this novel technique. Other variables which will be studies are different pore sizes, pore configurations and arrangements in the membrane. This will be done at photosynthetic B.V. in Amsterdam.

The fabricated membranes will be fully characterised using scanning electron microscopy (SEM) and a contact angle goniometer to obtain the morphological and surface wetting properties, respectively. These membranes will be tested for pure water permeability and wastewater treatment. For this, synthetic wastewater will be used which is made using micropollutants, bovine serum albumin (BSA), or oil droplets to study filtration capabilities of fabricated ultra and microfiltration membranes, respectively. Lab scale membrane filtration facilities will be used for both wastewater filtration as well as pure water permeability experiments. The whole characterisation will be done at the P&E, separation lab.

Reference

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