

# SEMS: RESEARCH PROJECT DESCRIPTION

## 1. Project Background and Description

### PEEK Membranes for Molecular Separations in Organic Systems

Organic Solvent Nanofiltration (OSN) separates molecules present in solutions of organic solvents. In OSN, a pressure gradient is applied across a solvent stable nanoporous film, inducing transport of liquid across the film. Depending on relative permeation rates, molecular species in a feed liquid stream can be concentrated and separated. Typically OSN will use a small fraction of the energy of thermal methods such as evaporation and distillation, and can work at temperatures around ambient. These advantages have led to a huge surge in interest in OSN technology in the past few years, and a rapidly increasing number of commercial applications.

The key challenges in fabricating membranes for OSN include ensuring solvent stability, controlling molecular selectivity, and building in robustness in the form of resistance to physical aging.

This project will focus on membranes formed by phase inversion processes from polymer-solvent mixtures, using poly-ether-ether-ketone (PEEK) as starting point. PEEK is stable in nearly all organic solvents and resists physical aging well due to its semicrystalline structure. It is an ideal polymer for OSN membranes, and this project will seek methods for membrane fabrication from PEEK. The aim will be to prepare PEEK membranes with controlled selectivities that can separate solutes in the range 500 – 5,000 g mol<sup>-1</sup>. These membranes will be prepared first as small size bench cast materials, and then fabrication will be developed as a roll-to-roll process. To control selectivity, molecular nanomoulds will be incorporated into the polymer films and then removed by etching to leave a finely tuned pore structure.

The membranes created in this process will be tested for applications in the synthesis of macromolecular drugs such as oligo and peptide therapies, where iterative synthesis processes based on membrane separation can open routes to new, exact polymer drugs.

## 2. Project Scope

1. Investigate and understand the relationship between membrane preparation protocols and membrane structure and performance for PEEK polymers.
2. Invent new ways of using nanomoulding to provide a uniform and well-controlled nanoporous structure in PEEK membranes.
3. Explore utility of PEEK membranes in synthesis of macromolecular pharmaceuticals by iterative synthesis.

## 3. Desired Skills from the Student

*Key skills needed for the PhD project*

Interest in advancing separation science and technology.

Ability to formulate research questions in a way that leads to a deliverable plan for research.

Ability to develop creative new techniques and processes in the laboratory.

Imagination and willingness to think beyond the dominant paradigm.

Ability to use simulation tools and develop and work with conceptual models.

Excellent writing and presentation skills.

#### 4. Supervisory Team

*Add supervisory team details*

Primary: Professor Andrew Livingston

Secondary: Dr Yao Lu, Chemistry

*Additional: (Name (inc title)/ department or company if outside SEMS).*