

**NUS Graduate School for Integrative Sciences and Engineering
Research Project Write-up**

Title of Project : Membranes for Biofuel Purification and Separation

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Short Description

Energy has progressively become a major global concern due to the new highs in oil price. Among many alternatives, biofuel is the most environmentally friendly energy source.

Biofuels generally include methanol, ethanol, butanol and biodiesel. The major challenge to biomass use is the technology development for the separation, purification, and transformation of it into biochemicals and biofuels. Currently, “separation” alone accounts for 60 to 80% of the process cost. Using membrane technologies with sub-nano pore sizes to facilitate biofuel separation and purification from biomass appears to be a very promising, economic and practical approach. Not only membranes offer superior advantages over distillation to breakup azeotropic mixtures for biofuels but also have unique features of low energy consumption, minimum contamination and maintenance.

There are three stages in the biomass-to-biofuel process; namely, conversion of biomass to fermentation feedstock, fermentation using biocatalysts, separation and concentration of the fermentation products to yield biofuel. This proposal will mainly focus on the 3rd stage that is to separate and concentrate biofuel from the fermentation products. Bioethanol and biobutanol and their water mixtures will be chosen as our model solutions in this study.

The objectives of this proposal are as follows:

1. To set up a membrane biofuels separation system and conduct fundamental research, from the aspects of membrane materials, sub-nano pore size formation, materials modification, membrane configuration, system design and simulation.
2. To develop proprietary membrane materials and hollow fiber membranes with desired sub-nano morphology, anti-swelling characteristics, balanced hydrophilic and hydrophobic properties for the pervaporation dehydration of biofuel and water mixtures.
3. To explore hybrid systems consists of ultra-filtration and pervaporation for biofuel purification and separation.
4. To mathematically model and optimize the membrane separation process for biofuels separation based on the solution-diffusion mechanism coupled with conductive and convective heat and mass transfers.