

Synthesis and Characterization of Ordered Polymer Films From Complex Macromolecular Structures

1.0 Outline of PhD Project:

Summary:

This project will investigate methods for the formation of thin porous polymer films. The utilization of these films could be in specialised separation and high technological applications, for example, membranes, tissue engineering, bio assays, micro reactors, photonic band gap and opto-electronic devices. This project will utilize complex macromolecular architectures as precursors for the formation of these films concentrating on the synthesis of functional materials.

The project can simply be broken down into the following areas:

- 1.1** Synthesis of complex polymer architectures:
 - a.** Synthesis of functionalized star polymers.
 - b.** Synthesis of well defined block-copolymers.
 - c.** Synthesis of dendrimers.
 - d.** Synthesis of environmentally responsive stars/block copolymers (smart polymers).
- 1.2** Characterization of complex architectures:
 - a.** Use spectroscopy techniques (NMR, IR, UV, MS).
 - b.** Use of chromatography techniques (GPC, GC).
 - c.** Use of high resolution microscopy (TEM, SEM, AFM).
 - d.** Use of Scattering techniques (MALLS, DLS).
- 1.3** Formation of Polymer films:
 - a.** Utilizing a simple but robust casting technique based on self assembly to form highly ordered Honeycomb films.
 - b.** Solution casting of polymers-study of morphology changes due to environmental switches (pH, Temperature).
 - c.** Characterization of these structures by high resolution microscopy (TEM, SEM, AFM).
- 1.4** Post Modification of honeycomb films: to increase the strength of the films, the films will be cross-linked by a variety of methods to increase the films applicability to membrane processes. Functionalities will also be introduced.

2.0 Travel Proposal and Relevance:

I propose to travel to United States of America for approximately three months (July-Sept 2005) there are two main areas related to my thesis that I wish to gain a further understanding from experts in the field. The first area is the synthesis of dendrimers for applications in thin polymer films. The other area is in the morphology of block co-polymer films and visualization of individual macromolecules. I also wish to attend an international conference, below is an outline of my proposal:

2.1 *Synthesis of functional dendrimers.*

I propose to spend 6 weeks at University of California Santa Barbara there I will work with Dr. Craig Hawker who is a world leader in the synthesis of dendrimers for film forming applications. Dr. Hawker has recently been appointed director of Materials Research Laboratory (MRL) and is also on the advisory board of the International Centre for Materials Research (ICMR) both of these centres are strongly interested in international collaborations. Work in these laboratories will give invaluable insight in to this area (1.1.c) as Dr Hawker has published 111 papers in the area of dendrimer synthesis, including 14 reviews.

2.1.1 Attend Wyatt Light Scattering University Santa Barbara, 4 day course.

Whilst in Santa Barbara I will also attend a specialised training course on the theory and application of Multi Angle Laser light Scattering (MALLS). The Polymer Science Group has a Wyatt Dawn instrument (MALLS). I will learn the full capabilities of this instrument which will benefit in analysis for my thesis (1.2.d), I will also be able to train the rest of my group so they will also benefit.

2.2 *Characterize functional star and block copolymers by high resolution Microscopy techniques;*

I propose to work with Professor Richard Spontak at North Carolina State University for 6 weeks. Prof. Spontak is a leader in the field of multifunctional block copolymers and runs a highly equipped microscopy centre. Prof. Spontak's Lab has developed a technique which constructs a three dimensional image from transmission electron microscopy data. This lab will be the ideal place for me to utilize his microscopy techniques to visualize my star polymers. Work to be completed will be visualization of individual star polymers and analysis of thin polymer films (from above 1.2.c and 1.3.b and 1.3.c).

2.3 *Give an oral presentation at the 230th ACS National Meeting, Washington DC, August 28- September 1, 2005;*

I would greatly benefit from the opportunity to present my work at an international conference.