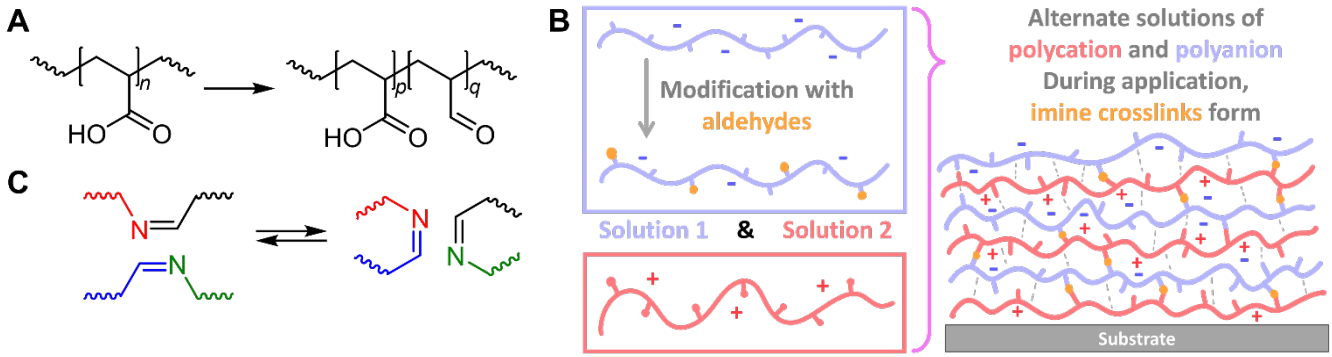
Group	:	Dynamic Polymers
Project	:	**Dynamically crosslinked polyelectrolyte multilayer membranes**
Supervisors	:	Martijn de Heer Kloots (PCC) and Maarten M. J. Smulders (ORC)

Introduction

Polyelectrolyte multilayers have been widely used to create coatings and membranes from simple solutions of polyelectrolytes in water. By alternating application of a solution of polycation (+) and polyanion (−), a robust, layered structure can be formed with a controlled thickness. The resulting membranes and coatings have recently been coined as environmentally friendly alternatives in the fields of separation science and water purification. However, the long-term stability of these membranes can be limited, especially due to (bio-)fouling, scaling and the high pressures applied. As such, harsh chemical and/or mechanical cleaning is often necessary to recover functionality, leaving the membrane prone to long-term degradation. Therefore, it is highly beneficial in these materials to aim for both additional mechanical stability as well as self-healing properties.

In this project, the polyelectrolyte multilayers will be dynamically crosslinked. The aim is to combine the robustness (offered by the crosslinks), with the possibility of repair and recyclability (enabled by the exchange between dynamic crosslinks). To this end, an existing anionic polymer, polyacrylic acid (PAA) will be chemically modified by converting part of the carboxylic acid groups into aldehydes (Figure 1A). These aldehyde groups can be crosslinked with a polyamine to create dynamic imine crosslinks. Essential elements in this design are that the system will be self-crosslinking upon formation of a polyelectrolyte multilayer (figure 1B), and that these imine bonds can continuously exchange (Figure 1C). In this project, it will be investigated if indeed these dynamically crosslinked polyelectrolyte multilayers can be formed, how their properties compare to conventional (noncrosslinked) multilayers (*e.g.*, in terms of mechanical strength and separation properties) and whether they have an ability to repair and/or recycle.



For this, the student will work both at the Laboratory of Organic Chemistry (for polymer synthesis and characterisation) and the Laboratory of Physical Chemistry and Soft Matter (for multilayer formation and characterisation). In addition, through a collaboration with the Membrane Science & Technology group at Twente University, part of the membrane testing can be done in Twente.

Research Objectives

- Modification and characterisation of aldehyde-containing PAA.
- Multilayer formation and characterisation (*e.g.*, multilayer growth, mechanical stability).
- Studying multilayer properties (e.g., self-healing, yield stress, separation properties)

Techniques to be used

- Polymer synthesis and characterisation (*e.g.*, NMR, FTIR, GPC, DSC, rheology, etc.)
- Membrane formation and characterisation (reflectometry, ellipsometry, Raman microscopy,)
- Multilayer preparation and characterisation (*e.g.*, water permeability and MW cut-off)

More information

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