FIELD FLOW FRACTIONATION AS A NOVEL METHOD FOR POLYMER ANALYSIS

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ABSTRACT

Materials with useful applications and well-defined properties have become increasingly important in recent times. Examples of these materials are macromolecular hybrids, polyelectrolytes and biopolymers. The characterisation of these materials requires accurate chromatographic techniques in order to carefully distinguish between the different polydispersities in the desired material. Polymer materials are polydisperse in various distributions, i.e. chemical, molar mass, functionality type and molecular topology. The exact knowledge about these different distributions is essential because they influence the processing and application properties to a large extent. For this reason the proper analysis of polymers which are polydisperse in more than one distribution is a very important aspect to focus on.

Polyrotaxane based polymer brushes are polymers with a distinct molecular architecture. These novel polymer materials are realized by the threading of a backbone polymer chain by cyclic molecules. In this study the backbone polymer chain was polyethylene glycol (PEG), while the cyclic molecules were α-cyclodextrins (α-CDs). After threading, bulky pendant groups were attached at the end of the backbone chain to prevent the α-CDs from dethreading. The polymer brushes were formed by the polymerization of poly (methyl methacrylate) onto the α-CD units. See Figure 1. These polyrotaxane based polymer materials were analysed by Size Exclusion Chromatography (SEC) and Assymetric Flow Field Flow Fractionation (AF4). Both fractionation techniques were coupled to a Multi-Angle Laser Light Scattering (MALLS) detector as well as a Refractive Index (RI) detector. The elution behaviour of these polyrotaxane based samples was investigated. Initial SEC results obtained showed a bimodal molecular weight distribution. High- and low molecular weight fractions were observed and a study was conducted based on SEC and AF4 to compare the two techniques and to identify the limitations of SEC. The main focus was to utilize AF4 in addition to SEC characterization to add more in dept information on the structure property relationships of these specific polyrotaxane materials. Results showed that as a specialized tool, AF4 can be used for the extended analysis of polymer molecules with sophisticated molecular architectures. SEC is not a suitable method for such samples because it does not properly address the fractions with very high molar masses.

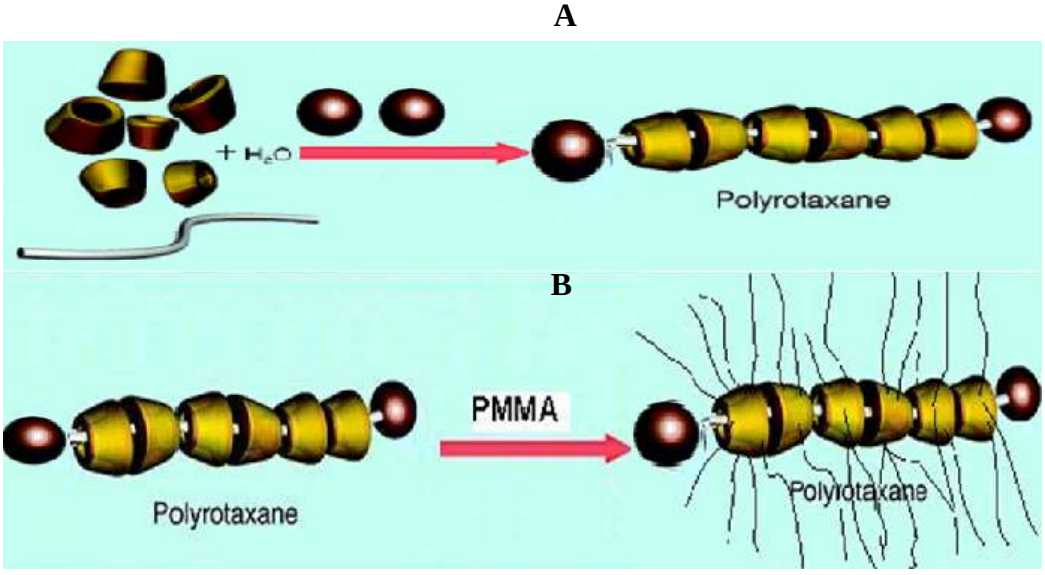

Figure 1. Simplified reaction scheme of polyrotaxane based polymer brushes. **A**) Rotaxation of PEG backbone chain. **B**) Attachment of PMMA side chains onto the α-CD units.