Polymer Basics

- Polymers are molecular structures which are typically composed of a large number of the same repeating unit. Polymers can also have distinct structures which can affect the properties of the polymer.

“Smart” Polymers

- “Smart” polymers respond to small changes in the environment in an intriguing way dissimilar to regular polymers. Viscosity is one way that changes in different conditions of pH, temperature, and polymer concentration.

- Cloud point is the temperature above which the polymer goes from “water loving” (hydrophilic) to “water hating” (hydrophobic) and becoming insoluble.

- PDMAEMA, the smart polymer being tested, has a cloud point that is affected by changes in pH, buffer concentration and polymer concentration. When PDMAEMA is used in a diblock copolymer with poly(ethylene glycol), PEG-PDMAEMA, it changes to take on different properties.

Applications

- Smart Polymer Drug Delivery
  - Smart polymers are of interest for drug delivery and other biomedical applications because smart properties, such as the switch in solubility, can be controlled in biological conditions.

- Polymer Synthesis
  - Atom Transfer Radical Polymerization (ATRP) is used to synthesize the diblock copolymer, PEG-PDMAEMA. The molecular weight can be controlled by changing the ratio of the monomer (DMAEMA) to the initiator (PEG-Br) as well as polymerization time.

Polymer Characterization

- One way to determine molecular weight is through Proton Nuclear Magnetic Resonance Spectroscopy (1H-NMR Spectroscopy). This instrument works by comparing the relative amounts of hydrogen atoms present in the polymer chains.

- All peaks are integrated relative to peak E. A comparison of E from the PDMAEMA block to G on the PEG block shows that the PDMAEMA is about 1.1 times longer.

- Another instrument that aids in characterization is Gel Permeation Chromatography (GPC) which measures the polydispersity index (PDI). This is a measure of the distribution of polymer chain lengths.

- The GPC is able to estimate molecular weight based on the retention time of the sample, and then compare it to a standard retention time and corresponding molecular weight.

- The polymer structure can be either a homopolymer, a polymer composed of one repeat unit, or a diblock copolymer, which is composed of two different repeating units that are covalently bonded together.

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Polymer Basics

Smart Polymers of Interest

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Applications

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- Rheological studies were done to measure the viscosity as a function of temperature below and above the cloud point. A cone and plate geometry of 25 cm² with a diameter of 40 mm was used at the shear rate of 50 s⁻¹.

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