Smart Polymer-Grafted SilicaParticles: Synthesis and Characterization of Smart Properties

Polymer and Colloid Basics
- Colloids are insoluble particles between 1 and 1000 nanometers in size suspended in a liquid.
- Colloids do not settle out or take a long time to settle out noticeably.
- Polymers are long chains of covalently bonded repeat units, called monomers.
- Polymers are both naturally occurring and synthetic.

“Smart” Polymers
- “Smart” materials change properties in response to an external stimulus.
- Certain smart polymers become water-insoluble upon heating. The temperature at which it becomes insoluble is the cloud point.
- Infrared Spectroscopy is used to ensure functionalization occurs. Peaks on the graph show different functional groups; double peaks around 1700 cm^-1 indicate carbonyl group from silane.

Functionalized SiO2 Characterization
- GPC (gel permeation chromatography) is used to characterize non-grafted polymers.
- NMR (nuclear magnetic resonance) is used to further characterize the free polymer.

Free Polymer Characterization
- Preliminary results indicate thermoresponsive behavior of the PDMAEMA grafted silica particles.

Confocal Microscopy
- Confocal microscopy uses a laser source and a confocal pinhole detector to achieve high resolution light microscope images.
- The ternary phase diagram shows how well the particles are dispersed.
- ATRP particles at 25°C show similar characteristics to bare particles at 25°C.
- ATRP particles at 50°C aggregate.

Silica Functionalization and Grafting-from Polymerization
- The silica particles are first reacted with silane to form a functionalized silica particle.
- Proper functionalization with silane is necessary to initiate Atom Transfer Radical Polymerization or ATRP.

Particle Synthesis
- Silica particles were picked because the size and functionality can be controlled.
- The Stöber growth process allows for controlled particle growth around a fluorescent dye (FITC or RITC).
- Incorporation of dye allows for characterization with confocal microscopy.
- Target particle size is 800-1000nm, this allows for proper characterization and helps particles exhibit similar characteristics when grafted with smart polymer.

Conclusions
- Particles of approximately 800nm in size have been successfully grown and characterized by use of the SEM.
- Silica particles were functionalized, polymer grafted, and then characterized using the IR, GPC, and Confocal Microscope.
- Preliminary results indicate thermoresponsive behavior of the PDMAEMA grafted silica particles.

Future Projects and Research Goals
- Study thermoresponsiveness for PDMAEMA grafted particles.
- Study how molecular weight and pH change cloud point.
- Graft particles with branched smart polymer.
- Observe settling rate of aggregated particles.

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