Influence of Ionic liquid and Light Intensity on Polymer Nanostructure within Lyotropic Liquid Crystalline Templates

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Controlling polymer properties via nanostructure

The development and control of structure on the molecular scale and nanoscale creates opportunity for tuning properties in polymers.
Self-assembling *lyotropic liquid crystals* (LLCs) utilized as photopolymerization templates.

Amphiphilic or surfactant molecules that self-organize into geometries with nanometer size dimensions.

Mesophase depends largely on surfactant concentration, polarity, and size.
LLC mesophases can serve as templates to **control polymer structure** on the nanometer scale.
Addition of Ionic Liquid

Ionic Liquids are purely ionic, salt-like materials that are liquid at unusually low temperatures.

- Thermal Stability
- Negligible vapor pressure
- Non-flammability
- Strong ionic conductivity
- Wide electrochemical stability window

The addition of ionic liquid potentially will enhance the thermodynamic stability of the mesophase and provide new properties in the resulted polymer.
The conservation of the optical texture after polymerization suggesting that increase of IL concentration into the LLC template enhances the retention of nanostructure.

Different concentrations ratios of CTAB and C7VImIL were tested.

Samples were polymerized at 10 mW/cm² for 10 min.

Before polymerization all the samples exhibit the birefringence texture of hexagonal mesophase.
DSC studies suggest that higher light intensity maintain the local order through polymerization to a higher degree.

- Three different light intensities were tested.
- Comparing the isotropic controls, it was determined that light intensity causes increase up to 35% on the reaction heat flow.
- Examination of the templated samples displays heat flow intensification up to three times compared to the isotropic counterparts.
Small Angle X-ray Scattering

- Relationship between nanostructure retention and light intensity was examined via SAXS profiles.

- The scatterings correspond to a mixed phase (hexagonal and lamellar).

- Polymerizing at 10 mW/cm² results in phase separation.

- SAXS scatterings verify the conclusions from the kinetic studies.

Pre-polymerization (--) and post-polymerization at: 10 mW/cm² (red), 15 mW/cm² (blue) and 20 mW/cm² (green).

SAXS scatterings reveals that the degree of retention is enhanced by increasing the light intensity.
Water percentage uptake

- Samples polymerized with 20 mW/cm² exhibit the greatest swelling uptake, swelling at 91% of their original mass in water.

- Templated samples showed the highest rates of water swelling reaching equilibrium in just 80 min.

- Isotropic controls decreasing the percent water uptake by approximately 40% due to the absence of nanostructure.

Retention of nanostructure enables improved transport properties, offering direct routes for robust contact between water and polymer.
Conclusions

The addition of IL enhanced retention of nanostructure through photopolymerization utilizing LLC templates.

Light intensity has been shown to affect the degree of mesophases transferred to the final polymer during polymerization.

The addition of IL could potentially allow to create polymers with new or improved properties that can be used in many commercially important applications.