Dr. Justin G. Kennemur

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B.S. Chemistry - (2002) – Radford University

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Senior Chromatography Analyst – (2002-2005) – Polymer Solutions Inc. , Blacksburg, VA

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Research in the Kennemur Group focuses on the design and synthesis of functional polymer systems with the goal of creating new materials that address key issues in society. An area of great interest is the ability of macromolecules to autonomously self-assemble into a hierarchy of secondary, tertiary, and even quaternary structures. By tailoring the design at the molecular level, we can investigate the important principles involved in these processes and ultimately tune properties to gain a desired function from the material. Our research is highly interdisciplinary and relies on organic and organometallic chemistry to create the materials, analytical chemistry to characterize their structure, and polymer physics and engineering to probe their function. Specific areas of interest include:

**Block Polymer Self-Assembly**

Block polymers contain two or more chemically distinct polymer segments that are covalently attached at one end. If the two segments are incompatible, (i.e. one is hydrophobic and the other hydrophilic) the segments want to completely phase separate but cannot due to their covalent attachment. A compromise between the thermodynamic desire to fully separate and the entropic penalty to do so, results in microphase separation or the formation of periodic nanostructures densely populated in either segment. The size and morphology of these structures can be controlled by the size of each polymer segment. Our research will explore new avenues of this self-assembly process and utilize some of the types of polymers described below to pioneer new applications in nanotechnology.

**Chirality in Polymers and Block Polymers**

Chirality is ubiquitous in both synthetic and biological polymers. Many commodity plastics, like polystyrene, contain one stereocenter per repeat unit and the sequencing of these units (known as tacticity) plays a large role on the bulk material properties. In nature, proteins utilize a ballet of stereospecific amino acids with hydrogen bonding capabilities to create secondary helical structures and tertiary helical bundles that offer complex functionality from molecular recognition and catalysis to structural support. Our research aims to judiciously incorporate chirality into synthetic homopolymers and block polymers to create materials that mirror these advanced functions but have improved properties over their biological counterparts.

**Renewable and Degradable Polymers**

Inherent to the synonymous boom of the petroleum and plastics industry over the last century, many of the polymeric materials produced today are derived from oil and are revered for their high chemical resistance and thermal stability. Although polymer longevity will always be necessary for some applications, there are many instances when a plastic serves a single function within a relatively short time frame and is then discarded. Drink bottles, plates, diapers, pens, and packaging materials are just a few examples of typical "single-use" items often made from polystyrene, polyethylene, or polyurethanes that will persist in the environment for thousands of years after their use has ended. A revitalized search has begun for new materials that rival modern petroleum based plastics but are derived from renewable feedstocks (i.e. plants and biomass) and are compostable or have improved degradation capabilities. This group will pursue new avenues within this growing area of research.

**SELECT PUBLICATIONS:**

**Kennemur, J. G.**; Yao, L. Hillmyer, M. A.; Bates, F. S. “Sub-5 nm Domains in Ordered Poly(cyclohexylethylene)-*block*-poly(methyl methacrylate) Block Polymers for Lithography” *Macromolecules*, **2014**, *47*, 1411-1418.*.*

**Kennemur, J. G.**; Hillmyer, M. A.; Bates, F. S. “Rheological Evidence of Composition Fluctuations in an Unentangled Diblock Copolymer Melt near the Order-Disorder Transition” *ACS Macro Lett.* **2013**,*2*, 496-500.

**Kennemur, J. G.**; Hillmyer, M. A.; Bates, F. S. “Synthesis, Thermodynamics, and Dynamics of Poly(4-*tert*-butylstyrene-*b*-methyl methacrylate)” *Macromolecules* **2012,** *45*, 7228-7236.

**Kennemur, J. G**.; Novak, B. M. “Hierarchical Chirality in Polycarbodiimides” *Isr. J. Chem.* **2011**, *51*, 1041-1051. (Special Issue: Origins, Transfer, and Amplifications of Chirality)

**Kennemur, J. G**.; Novak, B. M. “Advances in Polycarbodiimide Chemistry” *Polymer* **2011**, *52*, 1693-1710. (Feature Article)

