The self-assembly of block copolymers (BCP)s can facilitate materials design for many emerging nanotechnologies. In the Epps group, we are focused on understanding and applying the structure/property/function relationships inherent in nanostructured polymers to design, synthesize, and characterize new systems exhibiting molecular-level assembly. A particular interest in our research group is the coupling of thermodynamic and kinetic constraints in self-assembling polymers to develop materials for a variety of potential platforms including lithium battery membranes, green and bio-based materials, mechanical property enhancers, coatings, nanoscale templates, and drug delivery capsules. Three areas of recent progress in the group involve: (1) manipulating inter-block interactions to improve ion transport in block copolymers, (2) fabricating stimuli-responsive copolymers for gene therapy applications, and (3) designing bio-based alternatives, based on lignin, for thermoplastic applications. In the first area, we employ synthetic modifications to the traditional BCP architecture (using chemical tapering between blocks) to control the ordering transitions, glass transitions, and phase behavior in diblock and triblock polymers. Thus, we can create more processable and effective ion-conducting materials for lithium battery membranes. In the second area, we use photo-responsive functionalities, as well as our understanding of solution self-assembly, to create nucleic acid delivery vehicles. These systems show increased cellular uptake, stable packaging, on-demand unpackaging, and controlled/tunable/efficient delivery relative to standard nucleic acid transfection agents. In the third area, we explore the modification of lignin model compounds for use in the controlled synthesis of bio-based materials. One recent task has been the investigation of styrene-alternatives for BCPs with tunable glass transition and degradation temperatures that are suitable for thermoplastic elastomer applications.