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Functional bicontinuous nanostructures by in situ formation of block polymer modified thermosets¹

MARC HILLMYER, University of Minnesota

Block polymers are remarkable hybrid materials that can self-assemble on nanoscopic length scales. By controlling the composition, architecture, and molar mass, synthetic chemists can finely tune the morphologies adopted by these materials. Of the typical block polymer morphologies, bicontinuous phases such as the gyroid structure have been targeted due to their special utility in various applications that require interpenetrating domains structured on the nanoscale. While block polymers can be designed to self-assemble into such bicontinuous nanostructures, the window of thermodynamic stability is often quite narrow, and thus such structures can be difficult to experimentally access. In this presentation I will discuss the design, synthesis, self-assembly and applications of block polymer modified materials that adopt bicontinuous nanostructures through a polymerization induced microphase separation process. The enabling concept is the in situ formation of block polymers in a thermosetting system using controlled polymerizations such that their chemical synthesis and self-assembly occur in a single process. One of the important elements necessary for the adoption of bicontinuous structures is that the block polymer is crosslinked during synthesis to form a thermosetting material that results in chemical fixation of the final morphology. The central technique we utilize is controlled radical polymerization from a macromolecular chain transfer agent in the presence of a mixture of monomers that can undergo crosslinking reactions. I will discuss how we developed this approach, mechanistic consideration associated with the formation of bicontinuous structures, and applications of the resulting nanostructured materials in, for example, polymer electrolyte membranes for use in batteries and fuel cells.

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