

Star Block Copolymer Architectures for the Formation of Complex Morphologies and Pore Design

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Abstract:

Material properties are dictated not only by monomer composition but also by molecular architecture, particularly within block copolymers (BCP). Complex architectures that differ from linear block copolymers provide deeper insight into the formation and transformation of microphase structures. These topologies govern the curvature of the interface between two immiscible phases during self-assembly, directly influencing the resulting morphology. Particular attention should be paid to the formation of gyroid-like or bicontinuous structures. Such isotropic morphologies with nanometer-scale domain sizes can influence both the mechanical and optical properties of a material. Starting from dendrimer-like and H-shaped structures formed by anionic polymerization in a divergent arm-first approach, they give rise to interesting bulk morphologies. The insights gained are then transferred to porous structures using star-shaped, amphiphilic BCPs. The basis for the synthesis is a three-armed macroinitiator synthesized via ATRP using butyl methacrylate (BMA) and methyl methacrylate (MMA) in a core-first approach. To impart an amphiphilic character, the macroinitiator is complemented in a second step with a more hydrophilic poly(2-hydroxyethyl methacrylate) (PHEMA) block. This modular design yields star-shaped BCPs with various block ratios, which are compared in the pore-forming process. These results demonstrate the potential of star-shaped BCP architectures for high-performance applications, ranging from tunable ultrafiltration membranes to targeted surface modification of porous media to control water-vapor interactions.

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