“Guiding polymer assembly with molecular architecture”

Research interests are centered around shape-persistent macromolecules such as bottle-brush copolymers, as building blocks for nanoscale assemblies and functional materials.

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Abstract

Polymer architecture can be used as a powerful tool for the refinement of materials structure and properties without changing the chemistry of the monomer building blocks. We have used branched copolymers with a bottlebrush architecture to construct various nanostructured materials by covalent and non-covalent assembly. First, we exploited chemically reactive bottlebrush copolymers for the fabrication of mesoporous polymer frameworks. Orthogonally cross-linkable functionalities placed at bottlebrush ends and side chains were used for network formation and reinforcement of bottlebrush bridges connecting the network junction points. Mesoporous frameworks with pore diameters of 9-50 nm were obtained by simple solvent removal without necessitating templating, chemical etching or supercritical drying. Second, we explored architectural control of molecular packing during the assembly of two-component bottlebrush copolymers in solution and melt. Due to bidirectional nature of the bottlebrush architecture, we probed backbone and side chain asymmetries, as well as backbone chemistry and gradient interface as molecular parameters affecting the polymer morphology. Tapered bottlebrush copolymers, prepared by one-shot polymerization of macromonomers with vastly different reactivities, boasted a gradient transition of side chain composition between the two blocks. Such interfacial manipulation had a profound effect on polymer self-assembly, offering a new avenue for morphological control.