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Self-Assembly in Block Copolymer Solutions: Phase Behavior and Transition Mechanisms

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Block copolymers in solution and in the bulk can self-assemble into a variety of ordered mesophases, with associated lengthscales ranging from 5 to 50 nm. These materials are not only promising candidates for a host of applications, but also serve as model systems for exploring self-assembly processes in detail. We have conducted an extensive experimental mapping of the phase behavior of model copolymer systems, using x-ray and neutron scattering, rheology, birefringence, and dynamic light scattering. Much of the phenomenology can be understood qualitatively, and in many cases nearly quantitatively, through established principles. However, some intriguing features of the results are not fully understood. Thermally induced order-order transitions between structures also display a rich phenomenology, including epitaxy, asymmetric kinetics, and metastable intermediate structures.