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Stabilizing Various Bicontinuous Morphologies via Polydispersity of Diblock Copolymers

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Diblock copolymers are composed of two chemically distinct homopolymers, covalently bound end-to-end. One of the most notable features of block copolymers is their ability to self-assembly into a wide range of ordered periodic structures. There are many factors affecting the equilibrium morphology of diblock copolymers, one of which is polydispersity. The rich phase behaviour of polydispersed diblocks offers an opportunity to realize exotic phases that are not found in monodispersed systems. In this work, we explore the possibility of using polydispersity, in the form of binary mixtures of AB diblock copolymers, to stabilize the various bicontinuous structures, such as the double-diamond morphology. We focus on binary blends of B-majority diblock copolymers forming the double-gyroid phase, and A-majority chains that forms the homogeneous phase. The principal methodology of our study is the self-consistent field theory (SCFT). Solutions of the SCFT equations corresponding to the bicontinuous phases are obtained numerically, and the relative stability of the different ordered phases is then determined through a comparison of their free energy. The formation of the double-diamond phase is predicted for mixtures of specific compositions. Furthermore, we show that the stability of the double-gyroid phase can be greatly enhanced, such that the volume fraction of component A constituting the bicontinuous network exceeds 50%.

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