

Self-Assemble Nanostructures

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Self-assembled polymers can give rise to numerous different nanostructures. These thermodynamically-controlled, self-assembled morphologies of copolymers in selective solvents are themselves nanostructures and they can also be used as templates for synthesizing nanostructures. The use of self-assembled morphologies is a simple yet robust route for producing functional nanoscopic structures. Modifications to the polymers give rise to changes in the assembly conditions. We have successfully shown how different nanostructures can be obtained by using solvent treatment. To achieve novel structures, we went on to betainize polystyrene-poly(4-vinylpyridine). All these structures can be elucidated with the use of AFM and TEM. These structures has been proven be effective nanoreactors. Au particles of less than 5 nm can be synthesized using this method.

For copolymer fluids, the increase in concentration due to evaporation of solvent will lead to phase separation. In addition, convection exists within the fluids due to temperature gradient between the top and bottom layer caused by the evaporation latent heat of solvent. Surface-tension driven convection (Benard-Marangoni convection) originated from fluctuations of temperature result in ordered patterns [1].

In this work, we report the self-assembly of asymmetric diblock copolymers into surface micelles, which occurs during the adsorption of copolymers onto a solid surface from solution. These 2D structures, as shown in Figure 1, are the equilibrium configuration of the diblock copolymer in the presence of selective solvent, toluene. The films were deposited on solid surfaces by passive dipping technique which has been shown to form chemically inhomogeneous patterning masks with structure length or pattern distances in the nanometer range. Hence, the understanding of the physical principles governing the pattern formation enables one to control the scale, the morphology and the chemical composition of polymer aggregates. The morphology evolution of diblock copolymer polystyrene-block-poly(4-vinylpyridine)(PS-P4VP) thin film in the presence of different solvents was also investigated. It was also found that the pattern formed when the film is dried in air is different from when dried in nitrogen.

We have also for the first time successfully synthesized polystyrene-b-poly(4-vinylpyridine) (PS-P4VP) betaine copolymers which has a narrow molecular weight distribution and controlled diblock architecture. The selective betainization of the pyridine unit of this diblock copolymer was carried out in chloroform and toluene using 1, 3-propane sultone. The solution properties were studied using dynamic light scattering, static light scattering, TEM and ¹H-NMR spectroscopy. The size of the micelles formed was found to be strongly dependent on the amount of sultone grafted. The PS-P4VP-sultone micelle changed from spherical to cylindrical shape with different PS-P4VP to sultone ratio.

References

- [1] Normand C, Pomeau Y, Velarde MG. Rev Mod Phys 1977; 49: 581-87.

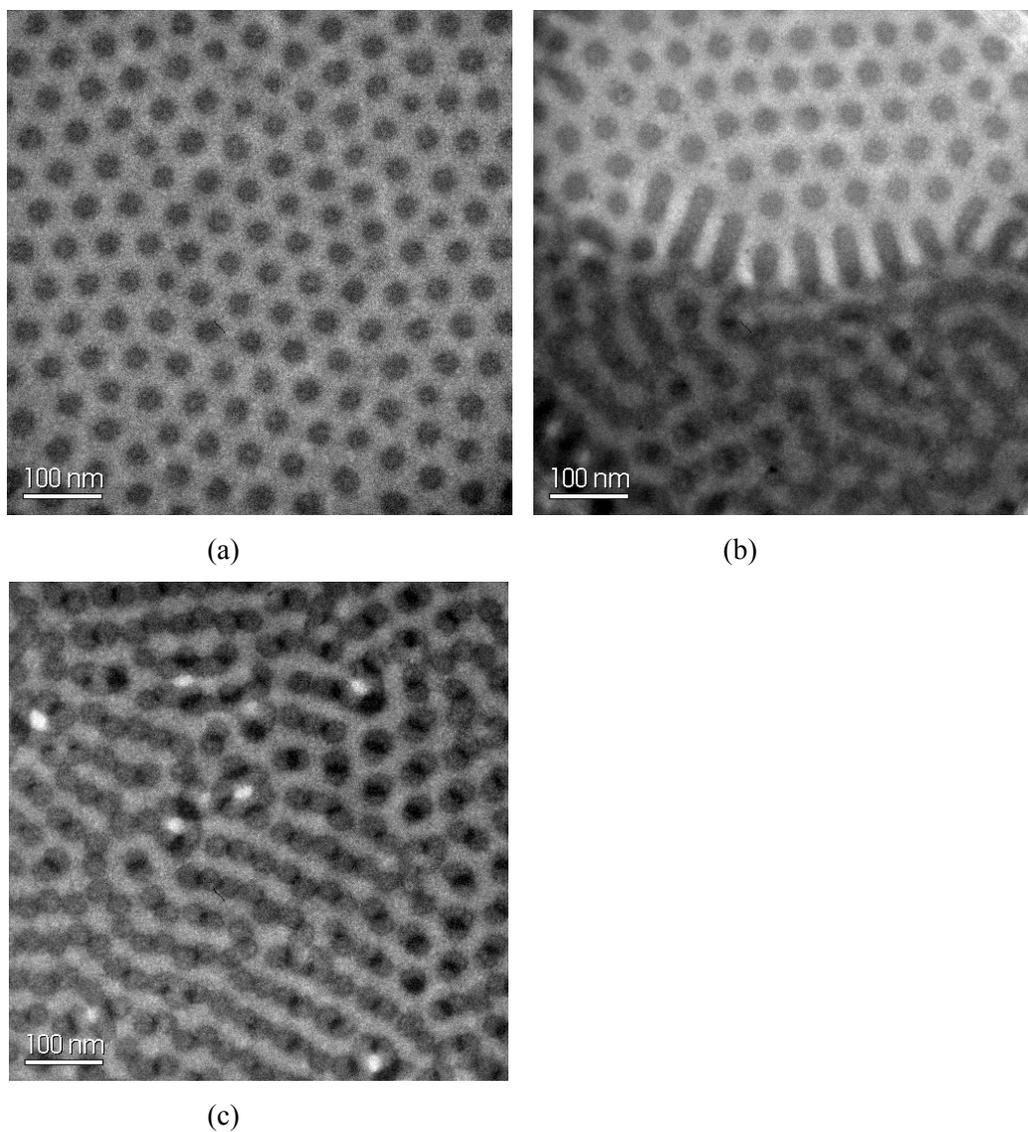


FIG. 1. TEM images of films cast from different concentration of diblock copolymer/toluene solution: (a) 2, (b) 8, (c) 13 mg/mL.