# Directed Assembly of Multiple Pattern Morphologies Using Block Copolymer Blends

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Directed self-assembly (DSA) is an emergent nano-lithography where self-assembling block copolymer thin films (BCP) are ordered using pre-defined guides patterned by standard lithography. In a typical DSA experiment, a lamellar or cylindrical BCP morphology is spatially templated by either topographic relief or chemical patterning of the substrate. Matching the spacing between the guiding features to the natural pitch of the polymers induces a high degree of long-range order in the nanoscale features. One challenge of DSA is the limited range of structures that can be fabricated, primarily because each BCP composition defines only a single equilibrium morphology.

In this work, we expand the traditional DSA chemical patterning approach in order to enforce the coexistence of multiple, aligned block copolymer morphologies, in a single patterning step. We pattern chemical line-grating patterns with different pitch and duty cycle by electron beam lithography exposure of PMMA resist on silicon wafers pretreated with a polystyrene (PS) brush. We then etch the brush, creating a chemical pattern and remove the remaining resist. Self assembly of either lamella-forming or cylinder-forming PS-b-PMMA block copolymers onto the chemical pattern results in well-ordered arrays of both vertical lamellae (‘lines’) and vertical cylinders (‘dots’) on the grating prepatterns, depending on the pitch and duty cycle (dose) of the pattern. Self-assembly of a blended 50/50 mixture of PS-b-PMMA lamellae and cylinders results in *simultaneous* formation of both ordered line *and* dot patterns in separate areas of a substrate prepatterned with gratings preferential for the formation of each morphology (Figure 1). Thus, by carefully designing the chemical template, we can preprogram desired spatial arrangements of different coexisting morphologies, self-assembled from a single blend.

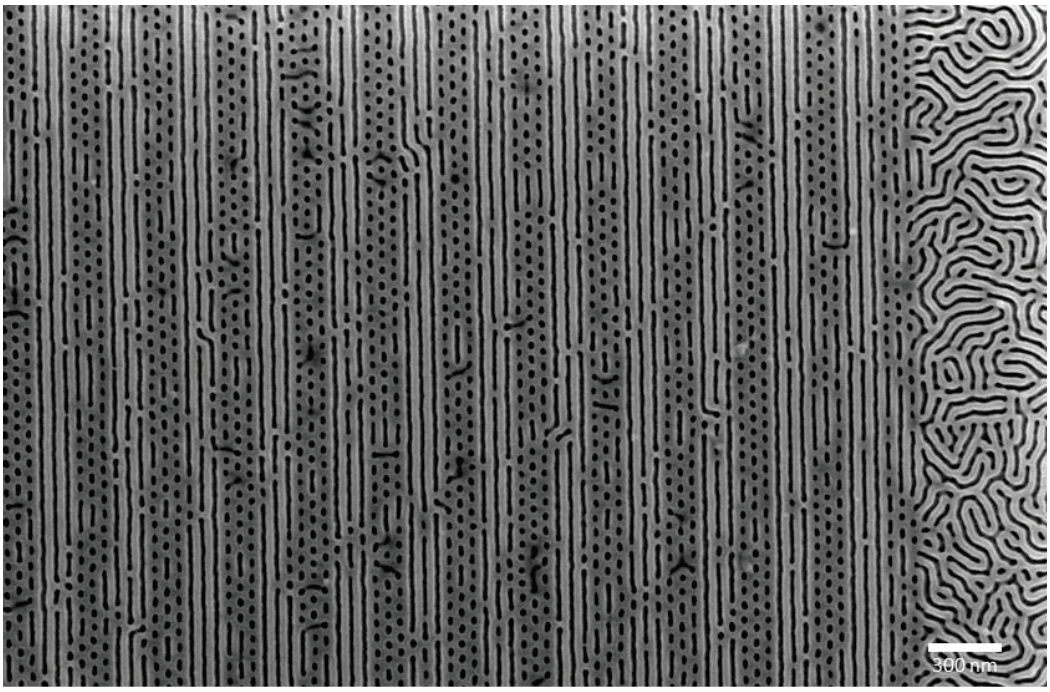


**Figure 1. Pattern of both lines and dots simultaneously formed by a PMMA-b-PS blend when applied to a grating chemical pattern. By carefully designing the pitch and duty cycle of the chemical template, we can preprogram desired spatial arrangements of different coexisting morphologies, self-assembled from a single blend.**