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Out-of-plane Block Copolymer Microdomains in High Aspect-Ratio Templates KARIM GADELRAB, WUBIN BAI, ALFREDO ALEXANDER-KATZ, CAROLINE ROSS, Massachusetts Inst of Tech-MIT — The use of directed self-assembly DSA of block copolymers BCP proved to be a power approach for nanoscale fabrication. It combines the ability of BCPs to self-assemble into nanoscale features with the use of lithographic tools to create controlled long range order. In addition, BCP with highly incompatible blocks (high Flory-Huggins interaction parameter (χ)) offer improvement in resolution, and line edge fluctuations of the self-assembled patterns. Unfortunately, high-χ BCPs usually exhibit large differences in surface affinity between the two blocks, leading to the formation of a surface layer of the lower surface energy block and favoring in-plane orientation of lamellae or cylindrical microdomains. Here, we explore the conditions under which a high χ BCP creates an out-of-plane lamellar structure using functionalized high aspect ratio trenches with preferential walls. We employ the free energy analysis of self-consistent field theory SCFT to identify whether an in-plane or out-of-plane structure is stable for a particular trench width. In addition, we employ the single mode expansion of Ginzburg-Landau free energy expression in the weak segregation limit to analytically construct a phase diagram of the in-plane and out-of-plane lamellae as a function of aspect ratio and surface attraction strength. It is found that achieving an out of plane lamellar structure necessitates a coupling between aspect ratio and surface functionality. In particular, strong side wall attraction results in out-of-plane lamellae when the trench aspect ratio is greater than unity. The results are validated for a lamellar forming polystyrene-block-polydimethylsiloxane (PS-b-PDMS) within trenches made using interference lithography.

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