Directed Polymer Self-assembly for Lithography Application

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Directed polymer self-assembly which combines lithographically defined prepatternd substrates and self-assembled polymers has been considered as a potential candidate to extend conventional lithography [1]. Much work over past few years has demonstrated that directed polymer self-assembly enables sub-lithographic resolution and/or improve pattern quality [2-5]. While significant progress has been made, the challenges of process integration, defect density, and dimensional control are major hurdles to directed self-assembly (DSA) impacting the lithography roadmap. This paper will discuss our studies on integration of polymer self-assembly with conventional lithography.

The self-assembly of block copolymers which phase separate into nanoscale periodic domains provide a mean to multiply the spatial frequency of the prepattern while improve the pattern quality. Lamella-forming PS-b-PMMA block copolymers are deposited on sparse chemical prepattern made by alternating resist and neutral surface and baked to generate line-space features with higher spatial resolution, precise placement and improved pattern quality [5]. Figure 1 show frequency doubling and pattern rectification of a target pattern based on this sparse chemical pattern approach. Figure 2 shows the overlay of resist prepattern and PMMA domains. The quality of the self-assembled line-space features depends on the DSA process as well as prepattern geometry. For example, defect-free frequency doubling of straight line-space patterns requires 1 minute annealing while it takes 5 minutes annealing to achieve defect-free frequency doubling of curved line-space pattern. Detail quantitative characterization of CD variation, defect density and pattern sensitivity of self-assembled features will be discussed in the presentation. Our results demonstrate that optimization in materials and processes can afford high quality self-assembled patterns of sub-lithographic resolution.

References:

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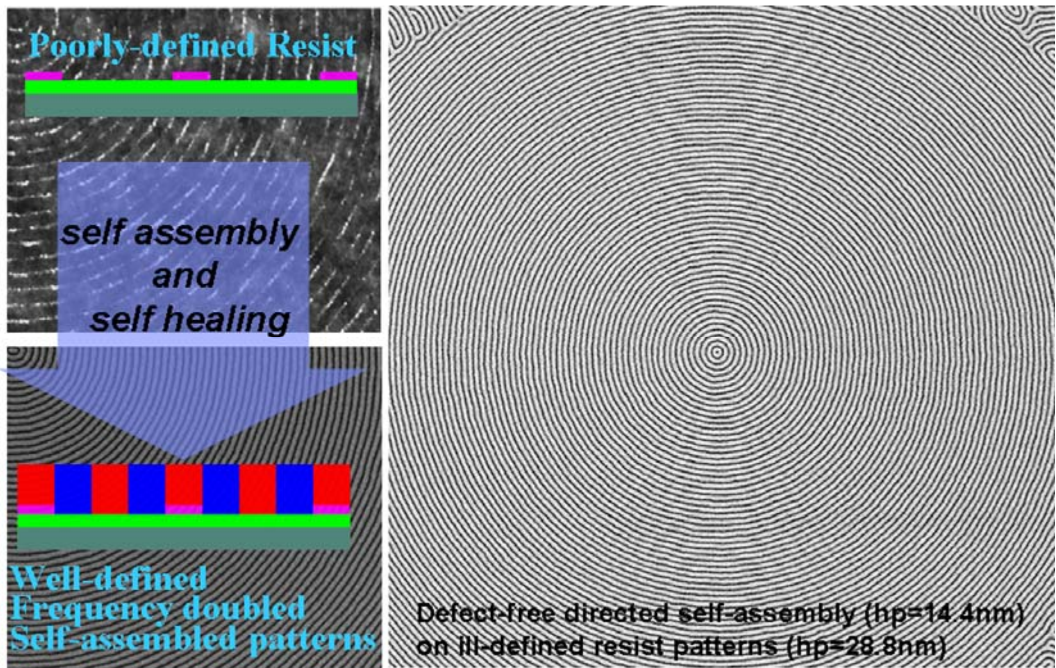

Figure 1. Self-assembly of block copolymers double the frequency of the resist pattern and heals the defects in resist.

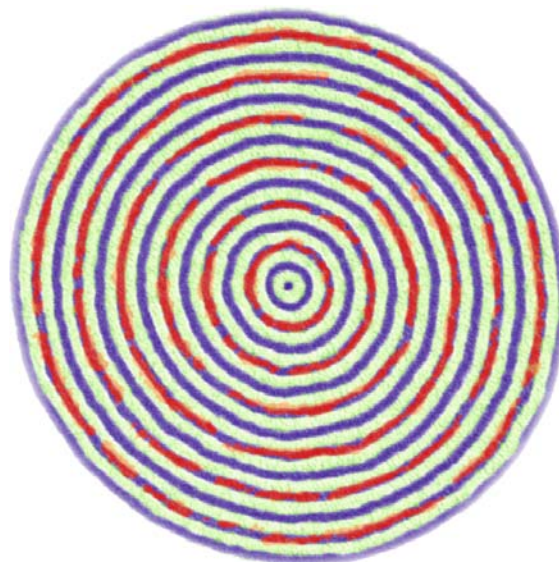

Figure 2. Overlay of resist pattern (red) and PMMA domains (blue). Self-assembly domains significantly improve the pattern quality of the resist prepattern.