Design and Customization of Directed Self-Assembly Patterns

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Abstract:

Directed self-assembly (DSA) of polymers, which combines self-assembled polymers and lithographically-defined directing prepatterns, provides a material-based resolution enhancement technique to extend the patterning capability of lithography. The phase-separated polymers offers feature dimension and uniformity which is difficult to achieve at the resolution limit or throughput limit of lithography. As a materials-based resolution enhancement technique, DSA has been used to augment the patterning capability of optical lithography, EUV lithography and E-beam lithography. Recently, DSA has been transitioned from experiments in the research labs to the feasibility evaluation at various pilot lines. For example, gridded lines and hexagonal arrays of vias from DSA have been demonstrated on 300mm wafers.

Many semiconductor device layouts involve complex patterns beyond simple arrays naturally achieved by the self-assembly of block copolymers. In this paper, we will present two DSA approaches for generation of complex patterns: model-based design for non-gridded layout and customization of gridded patterns. For example, targeted via arrays beyond hexagonal symmetry can be designed using compact DSA model. In addition, customized line-space arrays can be generated by co-optimizing DSA materials, DSA process and directing prepatterns. Design restrictions and characteristics of these complex DSA patterns will be discussed.